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Engineering News-Record

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ENGINEERING NEWS-RECORD

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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The Contractors Meet

CONTRACTORS are called to meet again in annual convention at Washington, D. C., in January. This will be the sixth yearly meeting of the Associated General Contractors of America. In the five years that have elapsed the A.G.C. symbol has become recognized as having a real meaning. The association in that time has become accepted into the society of engineering organizations of old standing. The coming convention sounds, therefore, an impelling call to all those who construct. There should be active response. The year has been a good one to contractors generally. They should attend to give their help. Others whom the year has hit with less fortune should come for the help they will receive. Above all the Associated General Contractors is an organization for direct practical service to its members. Its broad activities in improving contracts, in reforming bonding practice, in upholding the contract method for public works and in stabilizing the industry generally are not the tale of its services. In this respect it differs from most of the engineering associations. Personal aid to members is an important part of the work of the executive officers of the Associated General Contractors. There should be a wide attendance in Washington on Jan. 12-14 of contractors outside of the association to learn what the association gives its members in dollar-saving service.

Broad Research Organization

IN ESTABLISHING a research department, under the name of Institute of Research, Lehigh University has departed from the traditional conservatism of Eastern colleges and made an interesting application of a Western system. Such colleges as Illinois, Iowa State and Wisconsin long ago achieved significant success in their engineering experiment stations. President Richards thus has ample warrant for setting up the Institute. His long experience as director of the Illinois station, moreover, served as a sure guide in shaping the details of the Lehigh organization. But he has made a remarkable departure from precedent; he has created a device for general research rather than merely engineering research. The Institute is intended to develop a desire for new knowledge in history, in language or in economics as much as in concrete or in fatigue of metals. This is to be welcomed; whatever encourages and increases the aim for more knowledge in any one field will react also on other fields. A broadening of research activities, therefore, can not be otherwise than helpful to those who are interested in engineering research specifically. Yet the chief opportunities of the new Institute are likely to be in engineering, where the testing machine and the dynamometer afford precise methods of comparison. Lehigh has produced notable results in its laboratories heretofore. Under the new organization it may be expected to make an even more distinguished record.

Road Grading Studies

THE economic study of haul in grading roads, which is summarized in this issue, is of particular significance apart from its practical conclusions. It represents in a real sense a departure by the Bureau of Public Roads from the kind of investigation which has naturally and logically most occupied its research engineers and which is the study of road structure, vehicle action and traffic. In selecting earth moving operations for its first investigation the bureau heads have shown that they are thinking straight. When all road work is considered it is into operations akin to grading that most of the year's billion dollar expenditure goes. Yet there have been hours of thought on ways of handling concrete and asphalt and brick into pavement by engineers who have not found seconds to give to study of the one task which is never absent from the construction of any road. There should be more of these construction methods studies by the bureau engineers.

Complicated Traffic Signals

TO DRIVE an automobile safely through the crowded streets of our cities or even on our crowded highways requires today a co-ordination of mind and hand and a nervous composure by no means attested by the superficial examination that drivers have to take in most states. But an added complication, which the licensing boards have so far not at all recognized, is the necessity for understanding the signals which are being placed at crossings. The railroad engine driver who has to recognize two or three primary colors and understand the significance of one or two changes of position has a simple task compared with the motorist, or in places pedestrian, confronted with a bank of signal lights of different shapes and colors and in a variety of positions, from which he is supposed to be able to tell not only whether he is to stop or go or turn right or left but also whether he is to pause to permit turning traffic, afoot or awheel, to make a right or left turn before he proceeds on his appointed way. If it is a familiar crossing he may, if blessed with a fair memory, behave himself as the traffic director expects, but if he is in a strange town, with its signaling methods devised according to the peculiar taste and fancy of the chief of police, he can only follow the leader and trust in God. In plain words, this complication of signaling is becoming ridiculous. Not only are there too many lights and colors in most of the later signals but there is too much individuality in the selection and arrangement of those colors. Standardization and simplification is demanded and any agency, be it engineering society, police association or that benevolent father of all simplification and standardization, the Department of Commerce, which takes a step toward reform will find millions of pedestrians and automobilists—which includes us all—rise and call it blessed.

Almost But Not Quite

IT IS curious how close experimenters can come to great truths or the fundamentals of great development without seeing clear through to the end of the passage. Time and again in reading scientific history one comes across a description of an experiment or an elucidation of a theory which in the light of our later knowledge contained all the elements for an overturning discovery and which the author, skilled in his art as he was, could not quite complete. Such an instance is revealed in a discussion on some concrete tests, which appeared in the Institution of Civil Engineers in May, 1852. Concrete blocks, or bricks as they were then called, were tested, and a few of them contained some iron rods. The blocks which contained the rods tested far above the others in strength, and this caused some questioning in the discussion of the tests. But the author, in answering this question, said that he "thought there was less importance to be attached to the presence of the hoop iron in the beams than had been supposed, since its collective amount was only equivalent to a bar of 1¼x1 in. and (the italics are ours) *a certain portion of the iron was by mistake disposed above the line of the neutral axis and became therefore practically useless.*" Here is the nucleus of the whole theory of reinforced concrete, understood and explained by an engineer in 1852, at least 20 years before a general appreciation of the function of iron in concrete was abroad, and certainly 10 years before even a few scattered engineers considered this feasible. But there is no record that the author carried his thoughts further. Hindsight is ever a more ready guide than foresight.

Defaulting Road Contractors

HIGHWAY building has a rather notorious reputation for defaulted contracts. Those engaged in the business—bankers, surety companies, contractors and engineers—have widely divergent convictions as to the reason. For the moment, however, we are concerned with one reason only as expressed by Charles M. Upman, state highway engineer of North Carolina. Quoting a record of "some ten or fifteen failures in North Carolina" Mr. Upham declares that "Eighty per cent of the cause is insufficient finances or incompetency of the contractor." Incompetency, he is disposed to think, is the principal cause. Coming from a particularly sane-thinking highway engineer the conclusion commands respect. It is bound, however, to be disputed. Contractors at least will be loth to admit that they alone are to blame for eight-tenths of all failures to come out financially even in the road building business. This figure puts a very small responsibility for default on weather, wage and price fluctuations, transportation faults, materials shortages, and the score of other variables in construction operations which can give or take away a profit on a closely bid road contract. Nevertheless the incompetent contractor is with us, perhaps more commonly in highway work than in other fields of construction, and every reliable contractor will subscribe to Mr. Upham's statement that "If there could be some way whereby these men are excluded from highway work, or forced to secure satisfactory supervision, then the number of defaults among highway contractors would be considerably less." The question is, What is the way?

Toll Bridge Possibilities

THE opening of the just completed highway bridge over the Hudson River at Bear Mountain, which is scheduled for next week, promises to give us an early demonstration of the earning power of a strategic link in a main highway system. In so doing, it will convict the money-lending fraternity of an unfortunate lack of financial vision. Capital for the construction of the bridge was almost impossible to obtain, and the enterprise was finally made possible only by the personal contribution of the bulk of the funds by one or two men. Similar difficulties in raising money have been encountered in other highway bridge projects. Prominent bankers have repeatedly stated that they do not care to interest themselves in private bridge construction, that it is a doubtful investment, and that in these days of large-scale public-works construction on low-interest money they are not convinced of the soundness of private bridge construction. All this in the face of the impressive size of the traffic demand and the visible growth of traffic needs.

Figures that bear quite directly on toll-bridge possibilities were reported recently from two widely separate points. The old Havre de Grace bridge of the Pennsylvania R.R., over the Susquehanna River, is now owned by the state and operated as a toll bridge. The toll receipts for the year ending Oct. 1 were nearly $190,000, of which, it is said, more than $120,000 was net profit. It will not take long at this rate of earning to amortize the cost of the structure. At Yankton, S. D., where a toll bridge over the Missouri River was completed less than a month ago, the first week's income exceeded $11,000, which, according to local report, "is a greater sum than had been anticipated." These bridges are at important strategic locations. But the same is true of the Bear Mountain bridge, and for that matter of most or all other toll bridges that have been seriously proposed. In each case the convenience of crossing by the bridge, as against the difficulty and inconvenience of crossing by ferry, assures the bridge a heavy flow of traffic, under the pressure of the traffic demand existing on either bank.

There are those who hold that the Bear Mountain bridge should have been built by the public authorities, and we are inclined to agree with them. But the important point is that it was not. Only after the Bear Mountain bridge was put under way did a movement for construction of a competing public bridge come into existence, and because of this movement the first steps toward the construction of a bridge at Poughkeepsie are now being taken. It is a very fair question whether any Hudson River highway crossing would be in existence within ten years from now, if nothing else than public initiative and public construction had been active.

In this connection it is worth while to record the unusual circumstances that brought the Bear Mountain project into being. Three years ago Frederick Tench and H. H. Sherwin, New York contractors, were engaged in building a suspension bridge over Rondout Creek, and in connection with this work had to travel frequently between Kingston and New York. During these trips the difficulty of crossing the Hudson, in the absence of anything other than ferry crossings, impressed them strongly and they became convinced that a bridge should be built, and that they ought to build it. Knowing the great volume of traffic on both banks,

they saw the certainty of a paying traffic over the bridge. They acted on their idea, found a suitable location and proceeded to develop a project, obtain a franchise, and push the undertaking through to construction. The bridge that will be opened next week is the result. It is an interesting case of private initiative accomplishing quickly what public effort would not produce in many years, if ever.

Toll roads are obsolete. Toll bridges in general are equally obsolete, and many people, believing that this is true of every toll bridge, consider any toll project an attempt to bring back conditions that the world has definitely outlived. But where public enterprise is unable or unwilling, and private enterprise is able and willing, to construct large and badly needed traffic crossings, does it not represent the logical method? As to the general philosophy of tolls on road traffic, that is another matter. It doubtless applies equally to tolls whether collected by public or by private authorities. The opening of the Hudson River vehicle tunnel and of the Philadelphia-Camden bridge, both of them publicly owned and operated but subject to tolls, will give better opportunity to consider the question.

A Century of Portland Cement

YESTERDAY the Portland Cement Association at its annual meeting at Chicago celebrated the one-hundredth anniversary of the patenting of portland cement. Joseph Aspdin, a bricklayer of Leeds, England, is the man who gets the credit for contributing to construction this universal material. On Oct. 21, 1824, he applied for a patent giving him monopoly rights in "England, Wales and the Town of Berwick-upon-Tweed" (why this village should be singled out deponent sayeth not) for what he called "Portland Cement," and on Dec. 15, 1824, the patent was issued. Cements had been used for centuries, hydraulic cements were well known in England and the continent and even the artificial compounding of lime and clay to produce something similar but more reliable than the natural Roman cements had been described and even patented a few years before, but Aspdin created a name and produced what must have been a sufficiently different product to warrant the patent office to grant letters on his invention.

His claims were simple and short. They were as follows:

> My method of making a cement or artificial stone for stuccoing buildings, water-works, cisterns, or any other purpose to which it may be applicable (and which I call Portland cement) is as follows: I take a specific quantity of limestone, such as that generally used for making or repairing roads, and I take it from the roads after it is reduced to a puddle, or powder; but if I cannot procure a sufficient quantity of the above from the roads, I obtain the limestone itself, and I cause the puddle or powder, or the limestone, as the case may be, to be calcined. I then take a specific quantity of argillaceous earth or clay, and mix them with water to a state approaching impalpability, either by manual labour or machinery. After this proceeding I put the above mixture into a slip pan for evaporation, either by the heat of the sun or by submitting it to the action of fire or steam conveyed in flues or pipes under or near the pan until the water is entirely evaporated. Then I break the said mixture into suitable lumps, and calcine them in a furnace similar to a lime kiln till the carbonic acid is entirely expelled. The mixture so calcined is to be ground, beat, or rolled to a fine powder, and is then in a fit state for making cement or artificial stone. This powder is to be mixed with a sufficient quantity of water to bring it into consistency of mortar, and thus applied to the purposes wanted.

This, then, was the first portland cement. It was not the production of a man who knew very well why the mixture he invented acted the way it did but he did know from long practical experience that by following certain rules, many of which he retained as a trade secret, he could produce a hydraulic cement of comparative uniformity, a strength somewhat higher than that of the comparable limes and a hydraulicity of the greatest importance in water-bound England where maritime structures comprised a major part of the engineering work of his day.

Aspdin's cement was little different in description from Frost's or Vicat's then well established but history tells us that he immediately opened cement works which grew rapidly and that his "portland cement," for a time a monopoly product, soon outstripped in sales all of its competitors. Mill methods must naturally have been developed which made the cement somewhat nearer what we now know as portland cement than this crude mixture described in the patent. In fact there is the possibility that sometime soon after 1824 Aspdin or his successors discovered the essential feature of a stable and sound cement, that is, the final burning of the clay and lime mixture to a state of incipient fusion.

Portland cement today is defined as "the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous material . . ." Aspdin, it will be noted, realized the necessity for the "intimate mixture" of clay and lime but his patent does not disclose the importance of the incipient fusion. In fact, the early cement makers feared the approach to vitrification and threw out all clinker that reached that degree of heat. But sometime after Aspdin, this peculiar necessity of a real portland was discovered. Possibly this was not until 1845 when I. C. Johnson of White's famous British cement works, a man then 34 years of age who was destined to live 67 years longer, accidently discovered that his supposedly overburned clinker produced a cement superior to anything yet made. Whoever first hit upon this fact, whether it was Johnson or someone earlier, was the real inventor of portland cement, as much as anyone could be the inventor of something which developed through the slow accretions of knowledge and experiment of the centuries.

But whether the father of the infant or not Joseph Aspdin was certainly the christener. He had something more, a lively practical and commercial interest which indicates that he possibly knew more about the material than he chose to make public. It is fitting that the passing of the hundred years since he first laid claim to the novelty be celebrated by the great industry which he and his fellows started. Portland cement is today comparable only to steel in the economy of structures. Builders are dependent upon it, designers would be lost without it. It is not yet the perfect product the idealist forsees, but it is so good a product that its users dislike to see it fall at all short of perfection and therefore welcome all the efforts made to throw light on its complicated composition and behavior. In its hundred years of denominate existence it has more than kept pace with the co-ordinate developments in the engineering world. May it continue to do so.

Building Black Canyon Irrigation Dam in Western Idaho

Concrete Dam of 184 Ft. Maximum Height Built by Bureau of Reclamation to Save Private Irrigation District—Water Level Controlled by Drum Gates—Concrete Proportioned by Abrams Method

By Walter Ward
Construction Engineer, U. S. Bureau of Reclamation, Denver, Colo.

THE LANDS of the Emmett irrigation district, in Gem County, southwestern Idaho, consist of 22,500 acres in the valley of the Payette River near Emmett. The land is in a high state of cultivation and includes many bearing orchards. It is irrigated from the Payette River by way of a canal extending 16 miles through the canyon of the Payette River. Because of the hazardous location of the canal, the annual maintenance and reconstruction charges were beyond the ability of the landowners to pay. The district was therefore confronted with the problem of allowing their farm lands to dry up and their orchards to perish or providing a water supply by some other means. The latter alternative they were unable to finance. To avoid the apparent certainty of this large tract of improved land reverting to desert the Secretary of the Interior authorized the construction of the Black Canyon dam.

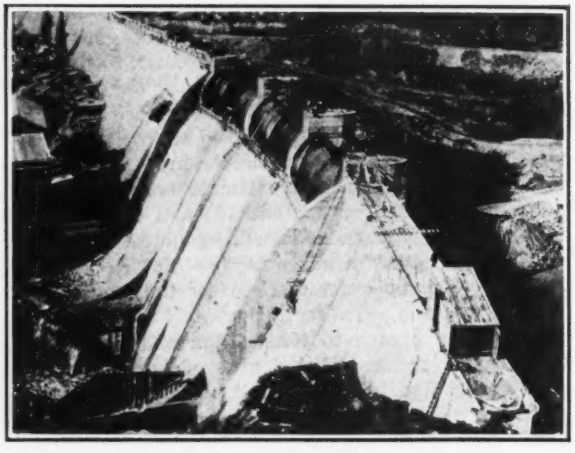


FIG. 1—BLACK CANYON DAM
Showing spillway section, with three automatic crest gates and curb walls along roliway.

The Black Canyon dam raises the water surface of the Payette River 92 ft., from which elevation water can be pumped into the district's main canal along the bluff near the north end of the dam, at the point where it emerges from the river canyon. This permits abandoning the 16 miles of canyon canal. A second purpose of the dam, which will ultimately be utilized, is to divert water into the main canal of the Black Canyon project, which is a federal reclamation project embracing 56,000 acres of land in the valleys of the Payette and Boise Rivers in Idaho. Electric power amounting to 12,000 hp. will be developed at the dam and used to pump the water for about one-third of the acreage of the Black Canyon project which cannot otherwise be watered.

The dam is 7 miles above Emmett and 32 miles northwest of Boise. Nature provided an ideal dam site at this point by pouring a ridge of lava or basalt across the river canyon, through which the river later cut a gash about 150 ft. wide. The gash extends down into the underlying sandstone, but the lava rock extending up to the water edge on either side materially reduces the required height of dam in this portion. The site is further favored by being at the point where the river emerges from the canyon and where the country below opens out into a wide valley, making an ideal location for a diversion dam.

General Type—The Black Canyon dam, a concrete gravity dam 1,134 ft. long and 184 ft. high, consists of an overflow or spillway section, which extends across the river channel, and abutments sections connecting to the rock bluffs. At the point of maximum height the base is 130 ft. wide.

The foundation is solid rock throughout and is exceptionally good. Under the abutments, extending to the river channel, the foundation was almost entirely a hard, dense basalt, making perfect contact with and supported by Colorado shale, which is supposed to extend down to a depth of from 1,000 to 2,000 ft. The basalt was crisscrossed with crevices 1 to 20 ft. deep and 1 to 6 ft. wide, providing many natural keyways. The foundation in the river channel, where the river had cut through the overlying basalt, was Colorado shale. The channel had an average width of 150 ft. with almost vertical side walls extending 85 ft. down from low-water level to El. 2,320. The bottom and sides of the channel were extremely irregular in shape, forming natural wedge-shaped keyways for this portion of the dam.

Grouting the Foundation—The rows of grout holes were drilled into the bedrock along the upstream edge of the dam for its full length. The rows were 5 ft. apart, the first row being 3 ft. from the upstream face. The holes were spaced 10 ft., and being staggered they provided a grout hole every 5 ft. They were drilled to a depth of one-third the height of the dam at that particular point, with a maximum depth of 25 ft. An 8-ft. length of wrought-iron pipe was fitted and sealed into each as it was drilled, and after the concrete of the dam had been poured to a minimum depth of 6 ft. the foundation was grouted with neat grout under a pressure of 100 lb. per square inch. The amount of cement used per hole varied from ¼ sack to 20 sacks and averaged 1.6 sacks.

After the foundation had been grouted a row of drainage holes was drilled 8 ft. downstream from the second row of grout holes, to 5 ft. less depth than the grout holes. The water from them is carried to a tile drain embedded in the concrete parallel with the axis of the dam, discharging through the downstream face at frequent intervals. The purpose of this drainage system is to collect and lead off any water that might accumulate and to prevent an upward pressure under the dam.

Expansion-and-contraction joints were provided at 73-ft. intervals in the spillway section and at approximately 50-ft. intervals in the abutment sections. To prevent leakage through the contraction joints the concrete was poured to form wedge-shaped corruga-

tions 4 ft. wide and 9 in. deep extending for the full height and width of the dam. These joints were grouted with neat cement grout during the winter months at the time of maximum contraction.

Design of Dam—The abutment sections of the dam have a vertical upstream face where the height does not exceed 77.5 ft., and for the greater heights a vertical face changing to a slope of 0.4 to 1 below El. 2,422.5 (the top of the dam is 2,500, sea-level datum). The downstream face of the abutments has a slope of $\frac{3}{4}$ to 1, except that the upper 27 ft. is the top of the gates when fully raised. The upstream face has a 0.4 to 1 slope from bedrock up to El. 2,422.5, and is vertical from here to El. 2,450. At this point a 10-ft. overhang was built to provide sufficient width on the crest to install the drum gates and permit the construction of a chamber into which the drum gates could be lowered. The downstream face has a $\frac{1}{4}$ to 1 slope except the upper 21 ft. which is curved to 60-ft. radius.

Training walls were built at the ends of the spillway section to keep the overflowing water within the

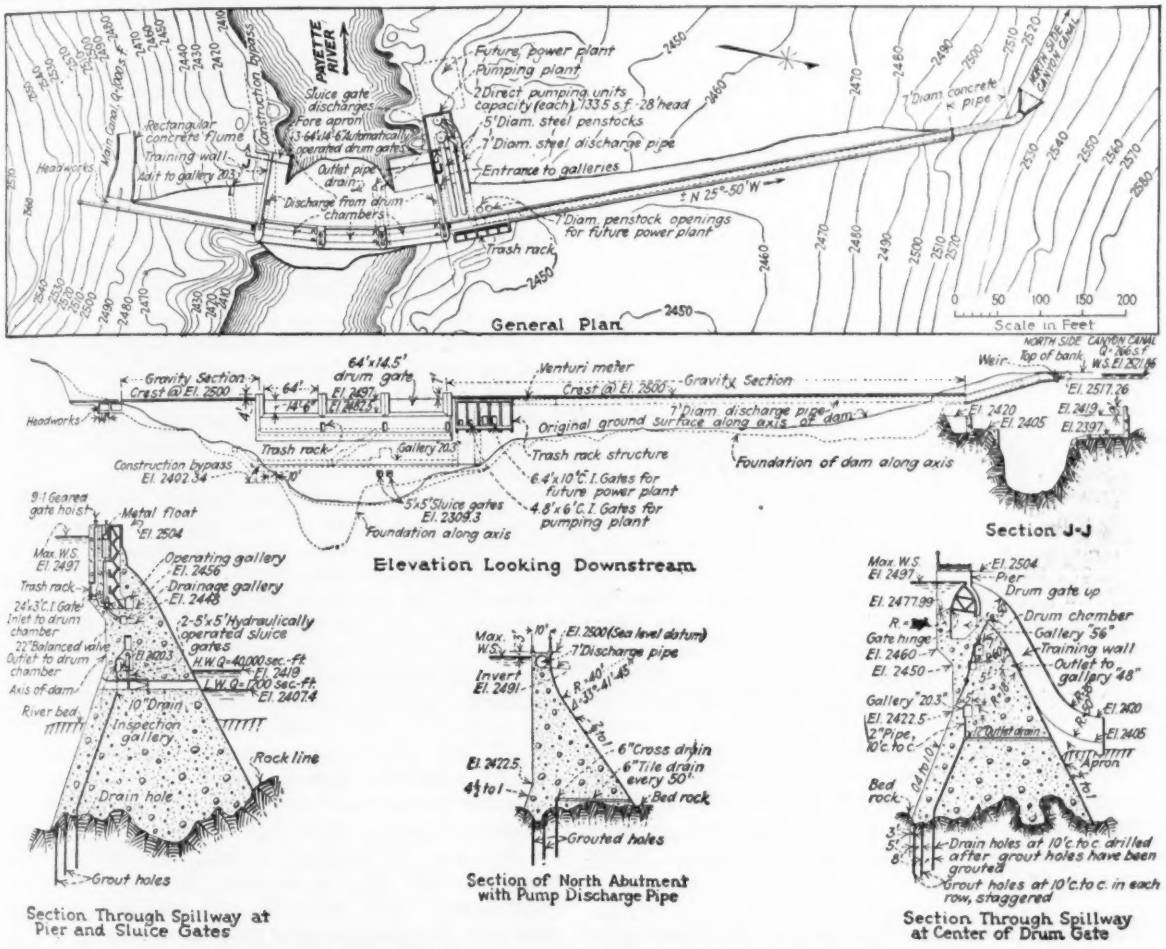

General Plan
Scale in Feet
Elevation Looking Downstream
Section J-J
Section Through Spillway at Pier and Sluice Gates
Section of North Abutment with Pump Discharge Pipe
Section Through Spillway at Center of Drum Gate

FIG. 2—ARRANGEMENT AND GENERAL DESIGN OF BLACK CANYON DAM

circular with 40-ft. radius terminating in a vertical face 5 ft. 2 in. high. The top of the abutment sections is uniformly 10 ft. wide through the masonry and has a 12-in. coping on each side. The north abutment is 709 ft. long and the south abutment 206 ft.

The middle or spillway section of the dam is 219.6 ft. long between centers of end piers and has a maximum height of 184 ft. Ordinarily this section could have been built in the form of an arch, but as it was necessary to install gates on the top for the proper control of the water level it was divided into three straight sections with angles of 6 deg. 50 min. with each other. This gives the dam some arch action and at the same time provides straight sections upon which to install the gates. Concrete piers between the gates extend 4 ft. above the abutment sections and 7 ft. above river channel. The north wall was extended downstream 198 ft. from the axis of the dam to form the river foundation wall for the pump and power house. The bench of basaltic rock between the training wall and the deep river channel was capped with concrete (after excavating the basalt to a depth of 14.5 ft. below low water) to provide aprons that would absorb the shock of the overflowing water.

Gate Installation—Two 5x5-ft. hydraulic sluice gates were installed. As the elevation of the gate sills is low, 2,409.3, these openings can pass the entire natural flow of the river for a considerable portion of the year. This will make it possible to work on the drum gates, drum gate operating machinery, or power and pumping gates and penstocks without interference from the river.

Three passageways or galleries were provided through the spillway section at El. 2,420.3, 2,448 and 2,456, and referred to as galleries 20.3, 48 and 56 respectively. Gallery 20.3 provides entrance to the sluice-gate operating chamber and also passageway across the river. Gallery 56 gives access to the operating chamber of the drum gates. Gallery 48 is a drain for the hydraulic operating mechanism of the drum gates, and discharges through the downstream face of the dam inside of the training walls.

Concrete piers at the ends of the drum-gate chambers divide the spillway section into three equal parts and house the operating machinery for the drum gates. Stairways lead from gallery 56 to the tops of these piers. Two hand-operated hoists are placed on the top of each of three piers. One hoist controls the cast-iron slide gate admitting water to the chamber under the drum gate and the second regulates the position of the pilot valve on the automatic balanced valve. Midway of the stairway are placed the valves that control the water leading to the float chamber and on the same level as gallery 56 is located the 22-in. hydraulically operated needle or balanced valve that automatically controls the drum gates.

The three floating drum gates are each 64 ft. long by 14½ ft. high. Each gate, weighing about 108 tons, floats in a chamber formed within the crest of the dam and its height is controlled by a hand-operated slide gate which admits water to the chamber below while a hand-operated 16-in. gate valve and a 22-in. balanced needle valve regulate the water flowing out. The needle valve is opened and closed automatically by floats which rise and fall with the fluctuation of the water surface above the dam. When the hand-operated gates are once set, thus establishing the position of the drum gates, the needle valve controlled by the float will automatically regulate the position of the drum gates so as to maintain the water surface elevation constant within 6 in. regardless of the amount of water passing. This close regulation is a very necessary feature on account of the presence of a branch of the Oregon Short Line R.R. along the south bank of the reservoir above the dam. The railroad in fact limited the height to which the dam could be built and required the installation of a pumping plant to raise the irrigation water 25 ft. from the reservoir to the Emmett District canal.

Pumping Equipment—Two vertical direct-connected pumping units were installed, each having a capacity of 133 cu.ft. per second. The units have a turbine and a screw pump keyed to a common shaft. Each is supplied with water by a 5-ft. steel penstock which divides a short distance from the units into a 4-ft. and a 3-ft. branch, the larger supplying the pump and the smaller the turbines. The flow of water to the penstock is regulated by cast-iron sliding gates 4.8x6 ft. operated by motor-driven hoists. Trash racks prevent the entrance of drift and weeds. Water leaving the pumps passes through mechanically operated 48-in. balanced valves into a 7-ft. steel discharge pipe serving both pumps, and thence into a 7-ft. reinforced-concrete passageway extending longitudinally through the crest of the dam to the canal on the north bank. The pumping units are housed in a concrete building 32x42 ft.

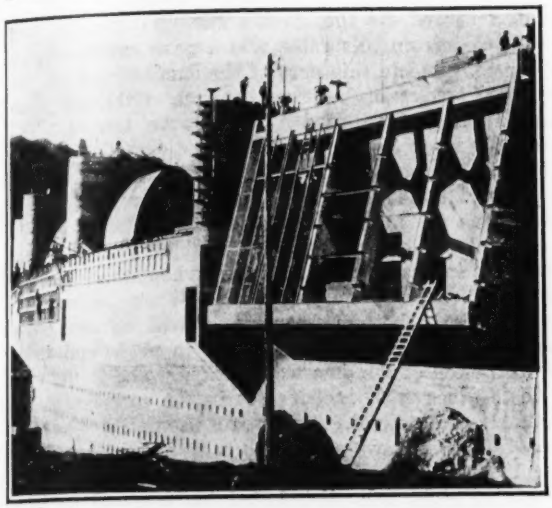
Future Power Installation—The development of power has not been completed. The foundation for the power house building and the draft tubes for two units were placed at the time the foundation of the dam was under construction. This much work on the power development was done when the river was diverted through a temporary bypass in order to avoid the expensive work of unwatering the power house foundation a second time. Two 8-ft. penstocks through the dam were also placed during the construction of this portion of the dam. It is proposed to install two units developing 12,000 hp. As the Black Canyon dam is a diversion dam an almost constant head of 90 ft. can be maintained on the turbines.

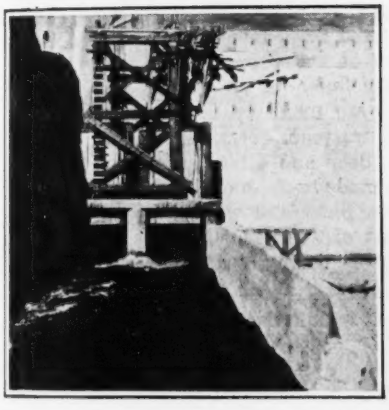
Conditions Governing Construction—The construction of Black Canyon dam was undertaken as an emergency measure to prevent the Emmett Irrigation District coming to disaster. As it was thought that the district could not possibly maintain the canyon canal longer than the end of the irrigation season of 1923 without rebuilding a large part of it, it was imperative that the dam and pumping plant be completed by the beginning of the 1924 irrigation season. From the time the construction of the dam was authorized to the date required for its completion there was available a period of 21 months to assemble equipment and materials and perform all construction work. The season of 1922 was so far advanced at the time the work was authorized that it was impossible to construct the spillway section, even to a safe point, before the river would again be in flood. Therefore the abutment sections were built first, leaving the spillway section to be undertaken as soon as the 1923 floods had subsided. Thus a full construction season was available for this part of the work.

Construction Plant—A 10-ton electric cableway was installed, which was extremely useful in the transportation of all materials and supplies. This cableway was equipped with a movable head tower, with a travel of 225 ft., which made it possible to control not only the whole dam but a considerable part of the plant layout. Its output was increased by operating it on a definite schedule. Certain hours each day were set aside for the cableway to handle concrete, followed by a definite time to move forms, place machinery, etc. In this way the foreman on each crew knew exactly when he could use the cableway and made his plans accordingly. The schedule was modified whenever necessary to meet changing conditions. The branch of the Oregon Short Line near the south end of the dam made the handling of freight to and from the works simple; a spur track was taken off the main line and extended around the point of a hill under the cableway, permitting the loading and unloading of cars with a minimum amount of hand labor. All of the equipment used was electrically operated except locomotives and two draglines.

The temporary diversion channel, 4,000 sec.-ft. capacity, was constructed along the foot of the bluff on the south side of the river. Above the dam this diversion channel was constructed by excavating through the rock ridges 24 ft. wide and building a concrete retaining wall on the river side. Through the dam section two 10x14-ft. concrete culverts were built, while below the dam the diversion channel was a reinforced-concrete flume. Gravel dikes at the ends of the channel diverted the water; they were made unusually water-

tight by digging a trench along the water side and filling with clay. When the dam was completed the channel was closed by dropping concrete gates into guides built into the side of the culvert walls, and the





FIGS. 3-5—BLACK CANYON DAM CONSTRUCTION

Fig. 3 (at top)—Construction of gate piers and trash rack support. Fig. 4 (at left)—Bypass culvert filled with concrete after completion of dam. Fig. 5 (at right)—Looking up Payette Valley at dam and construction plant; irrigation canal, which was abandoned on completion of the dam, in left foreground.

culverts were then filled with concrete through 12-in. pipe placed in the face of the dam for that purpose.

Hydraulic Stripping—The excavation for the abutments consisted of stripping a layer of soil ranging in depth from 1 to 40 ft. and picking out the soft seams and crevices in the rock. The stripping was done mostly with a hydraulic giant supplied with water by a two-stage 5-in. centrifugal pump. Water under high pressure was the only thing that would successfully and economically clean the very irregular basalt surfaces.

A trestle was built on the exposed solid rock on each side of the river channel. Trains of 4-yd. dump cars were operated on these tracks to haul away the excavated material.

The river or spillway section was excavated by three draglines, assisted by two 10-ton derricks with 80-ft. boom operated by three drum hoists, erected on convenient rock pinnacles on either side of the hole. The draglines loaded the first 20 ft. of material directly into 4-yd. dump cars running on a trestle built on exposed rock on either bank, and the balance into skips which were hoisted by the derricks and dumped into hoppers straddling the trestle tracks. The depth of the excavation was about 92 ft. and consisted of gravel and boulders. The diversion dikes proved to be so tight that very little water was encountered in the excavation; one 6-in. pump easily handled all of the water.

The concrete for the main body of the dam consisted of 1 cement, 3 sand, 3.9 gravel and 3.4 cobbles. Where extra strength was required and in thin walls concrete with reinforcing steel was used. In these places the cobbles were omitted and a 1:2½:5 mix was used. Sand was considered as that material which would pass a ¼-in. ring, gravel that passing a 2½-in. ring and retained on a ¼-in. ring, cobbles the material retained on a 2½-in. ring and passing a 6-in. grizzly. Prof. Duff A. Abrams' theory of proportioning aggregates was used with excellent results in determining the most economical mix

In applying Prof. Abrams' theory the problem consisted of determining what mixture or proportion of the aggregates available would give the required strength with a minimum amount of cement after adding sufficient water to give a workable mix. A large number of samples of the aggregate were screened to determine the fineness modulus, after which experiments were conducted to determine what combinations of the various sized aggregates would give the desired results. The experiments showed that several combinations would produce equivalent results and therefore selection was made of the one that would utilize the aggregate with a minimum of waste.

Handling Concrete Materials—A very good deposit of sand, gravel and cobbles was found in the bed of the river from ¾ to 1½ miles above the dam site. It was a typical swift water deposit of very hard, clean, washed granite rock sufficiently well graded to run through the screening plant and into the mixers with a small amount of waste. The aggregate was transported over a 36-in. gage industrial railroad in 4-yd. dump cars. Dragline excavating machines loaded the cars, digging from 4 to 8 ft. below the water surface. It was not possible to haul the aggregate directly to the screening plant to build the abutment sections as this part of the dam was poured during the time the river was in flood. Therefore this part of the aggregate was excavated before flood season and stored at

a convenient point and later reclaimed as needed by use of the same equipment. About one-half of the spillway section of the dam was built during the fall and winter months, permitting the hauling of a large part of the aggregate directly from the river bars to the screening plant. The draglines and gravel trains were operated at full capacity, storing the excess material to be reclaimed later when the river was again in flood.

When the aggregate was hauled to the screening plant it was first dumped into a 50-yd. storage bin. It was then passed from the bottom of this bin by means of an apron feeder to the boot of a bucket elevator. The elevator hoisted the aggregate 65 ft. and dumped it on grizzly bars spaced 6 in. apart. This was the only hoisting operation required, as the aggregates moved by gravity through all subsequent operations. The grizzly bars rejected all oversize material, which was returned through chutes to a rock crusher and after crushing was spouted to the boot of the elevator and rehoisted. The material passing the grizzly bars was passed through the screens and deposited in the sand, gravel and cobble bins. The aggregate was accurately measured in the batching boxes and spouted to a hopper above the mixers, where the cement was added. The batches from this hopper were spouted into 1-yd. concrete mixers and mixed a minimum of 1½ minutes after the water had been added.

TABLE I—QUANTITIES AND COSTS FOR BLACK CANYON DAM

Classification	Quantity	Unit Cost	Amount
Excavation, all classes	75,595 cu.yd.	$2.33	$176,125
*Concrete, plain	73,157 cu.yd.	7.56	553,066
Concrete, reinforced	5,836 cu.yd.	21.40	124,890
Gates and machinery			137,000
Structural steel	24,000 lb.	.105	2,500
Miscellaneous items: Drilling, grouting, drainage, hand railing, lighting			19,850
Right-of-way			85,000
Diversion works			70,000
Pumping system			120,000
Power system			30,000
Siphon			17,000
Miscellaneous features			29,243
Overhead: Camp operation and maintenance		1½ Per Cent	18,000
Engineering and inspection		2½ Per Cent	35,000
Superintendents and accounts		1½ Per Cent	25,000
General expense		4 Per Cent	65,000
			$1,507,674

Concreting by Cableway and Chutes—The concrete mixers discharged into 4-yd. cableway skips which were placed on flat cars. A small hoist shuttled these flat cars from the mixer to any point over which the cableway might be spotted. All the concrete in the abutment sections was transported by the cableway, and due to its movable headtower it could be spotted to deliver concrete to any point on the dam. When pouring concrete in thin walls a 3-yd. bucket with a hand-controlled discharge replaced the 4-yd. skips.

As the cableway did not have sufficient capacity to handle the concrete in the spillway section, a chuting system was installed. Cables were stretched across the river channel from which the chutes were suspended using a three-part line of manila rope. The chutes were U-shaped, 16 in. wide and 10 in. deep. Although good results were obtained, deeper chutes would have been better. The concrete at the mixers was discharged into specially built 3½-yd. cars and hauled in trains of two cars over the tracks previously used in the excavation of the foundation. The concrete was dumped from the cars into 6-yd. hoppers and was fed into the chuting system from these hoppers through hand operated gates.

When the spillway section had been built up to low water level, it was necessary to raise the chutes. Wooden towers 36 ft. high were erected on the ends of the abutment sections adjacent to the spillway section. A cable was stretched across these towers and anchored to the dam. The chutes were then suspended from this cable which gave sufficient headroom to complete this part of the dam by chuting. An inclined track was built on the face of the dam leading from the railroad track to the towers. Two specially made 3-yd. mine cars were operated on these inclined tracks which automatically dumped into a hopper of similar size built into the tower. The concrete was fed into the chutes from this hopper.

Formwork and Placing—Reusable wooden forms made up in panels were used throughout the job. Two sets of forms only were required. When the top form was filled the bottom form was moved up and set in position on top of the panel then in place, and so on until the top of the dam was reached. The forms were held in place with anchors set in the concrete as the concrete was poured. A plentiful use of these anchors and lining the forms up with a transit before filling them brought exposed faces true to line and grade.

Six to eight men distributed the concrete by hand after it was dumped or poured into the forms. Rocks were carefully spaded away from the face of the forms and any collection of water or laitance was promptly cleaned out. When finishing up a day's pouring, temporary keyways were made by stepping the concrete down toward the upstream form. These steps were a minimum of 6 in. deep and a maximum of 8 ft. apart. Special effort was made to clean old concrete thoroughly, using wire brooms, picks and water, before pouring a new lift. The cost of such cleaning was high, almost equaling the cost of placing, but the results justified the expense, as the construction joints were unusually free from seepage.

TABLE II—AVERAGE COST OF PLAIN CONCRETE, BLACK CANYON DAM

Classification	Cost per Cu.yd.
Preparing foundation	$0.01
Cement (including railroad freight)	3.37
Sand, gravel, rock, digging and hauling	.84
Sand, gravel, rock, screening	.28
Sand, gravel, rock, hauling from storage	.19
Heating materials	.07
Mixing, labor	.26
Mixing, power and lubricants	.05
Transporting and placing, labor	.76
Transporting and placing, power, fuel and lubricants	.04
Forms, labor	.41
Forms, materials	.13
Forms, plant charge	.06
Unwatering site, labor	.03
Unwatering site, power and lubricants	.03
Finishing concrete	.06
Sprinkling and protecting	.06
Water	.03
Minor equipment repairs and supplies	.07
Plant charge	.52
Equipment charge	.29
Total cost	$7.56

During the summer months the concrete was kept moist for ten days by sprinkling. In extreme hot weather it was covered with burlap to protect it from the direct rays of the sun. The protection of the concrete during the winter months offered a real problem, but by discontinuing operations when the temperature dropped below 10 deg. F. and resuming when the weather moderated to temperatures above that point the work was able to proceed, although slowly. The aggregate was warmed in the bins by steam jets and the mixing water was heated by pass-

ing it through a furnace. The fresh concrete was protected by covering it with canvas and turning live steam underneath.

The dam and pumping plant were complete with the exception of hand rail, lighting system, etc., on April 25 and the temporary diversion chanel was closed April 28. The water surface above the dam reached El. 2,497, the maximum height permissible, on May 5, and two days later the pumps were put in operation. The starting of the pumps was quite opportune for the Emmett Irrigation District, as a long stretch of its canal four days previously had failed beyond repair.

The total cost of the dam and pumping plant was $1,500,000. The unit costs and quantities making up the total are shown in Table I, while Table II gives the items of the average cost of concrete per yard. This average was $7.56, but the cost of the (plain) concrete ranged from $6.18 to $8.50 depending on weather conditions and amount of formwork.

The Black Canyon Dam was constructed by day labor. F. E. Weymouth, chief engineer, had general supervision of all the work. J. L. Savage, designing engineer, had charge of all designing work, and Walter Ward, construction engineer, had charge of all the field forces.

Tests of Air Pressure Losses in Activated-Sludge Plants

Observations on Cast-Iron Pipe, Venturi Air Meters, a Check Valve and Three Different Makes of Aeration Plates

By R. J. Bushee and S. I. Jack
Junior Engineers, Sanitary District of Chicago

THE DATA available on actual experiments under working conditions concerning air pressure losses in activated-sludge plants are very limited. The designer must adapt formulas for loss of head in pipes and fittings which were made for conditions other than those of the design, thereby introducing a considerable factor of error. While this method generally gives results on the safe side, it is not conducive to economic design. Consequently, tests were made at the DesPlaines sewage-works and at several testing stations of the Sanitary District of Chicago to determine some of the losses of head in pipes and fittings. Tests were made on 24-, 10-, and 4-in. pipe, several Venturi air meters and a 10-in. check valve, as well as on the loss of head through aeration plates.

Loss of Head in Pipes—The longest runs of straight pipe available at the DesPlaines plant were used for the tests. The 24- and 10-in. lines were tapped for ¾-in. nipples on the upper side and ⅜-in. pressure lines run to a water manometer where the differential head gave the loss in the pipe. The 4-in. pipe was tapped for ¼-in. nipples with ⅜-in. pressure lines. The distance between the taps was 203 ft. for the 10- and the 24-in. lines and 132.8 ft. for the 4-in. pipe. The rate of air flow was measured with Venturi air meters with automatic recorders in the case of the 24- and 10-in. pipe and a water manometer for the 4-in. pipe. The rates were corrected for temperature and for pressure measured by a mercury manometer tube.

The results of the tests are given in Fig. 1, together with the losses computed by the Fritzsche formula

$$p = \frac{1.268\,tLQ^{1.85}}{10^6 pd^{4.87}}$$

where t = abs. temp. in deg. F.
L = length in ft.
Q = cu.ft. per min. free air at 60 deg. F. 14.7 lb. abs.
p = abs. press. in lb. per sq.in.
d = diameter in inches.

(see *Engineering News-Record*, Aug. 2, 1923, p. 178).

The principal variation from Fritzsche's formula was in the coefficient 1.268 which should vary for different conditions of roughness.

The 24-in. main supplying the air for the aeration tanks, of 10 ft. depth, was class A cast-iron bell-and-spigot pipe. The observed pressure loss was about 20 per cent greater than that computed from Fritzsche (Fig. 1).

The 10-in. main supplied the air for the aeration tank of 15 ft. depth as well as for the air lifts and

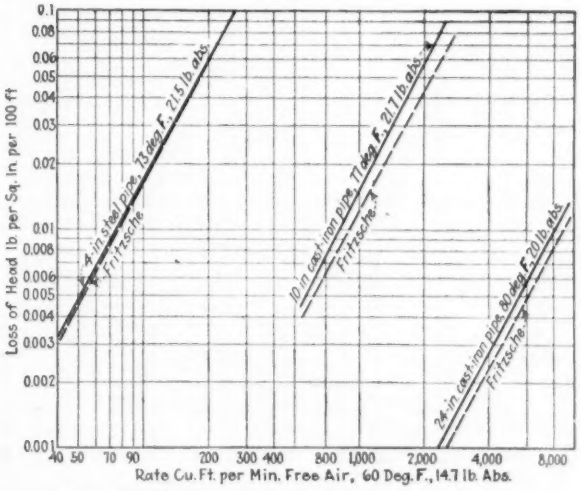


FIG. 1—AIR-PRESSURE LOSS OF HEAD IN 4-IN. STEEL AND 10- AND 24-IN. CAST-IRON PIPE

aeration of the sludge channels and sludge storage tanks. It was also class A cast-iron bell-and-spigot pipe. In this case the observed pressure loss varied as the 1.91 power of the quantity rather than as the 1.85 power as given by Fritzsche. For this reason the observed loss varied from 15 per cent more than Fritzsche at 650 cu.ft. per minute to 35 per cent more at 2,500 cu.ft. per minute free air at 60 deg. F. 14.7 lb. Twenty-five per cent would be a good average to add to the losses calculated from the Fritzsche formula, for rates between these limits for this size of pipe, for design purposes.

The 4-in. line was a steel pipe line supplying the sludge storage tanks. The pipe was very rusty on the outside and probably on the inside. All of the pipes tested had been in use for about fifteen months. The losses in the 4-in. line check very closely with those given by Fritzsche.

These results indicate that for 10- to 24-in. cast-iron bell-and-spigot pipe the loss will not be far from the actual conditions if computed by the Fritzsche formula and multiplied by 1.25. The test on the 4-in. pipe would indicate that the Fritzsche formula is practically suitable for wrought-iron and steel pipe and does not give too low results for galvanized iron pipe.

Loss of Head in Venturi Air Meters—Some tests were made of the losses of head through cast-iron Venturi air meters with the elements of the recovery

tube making an angle of about 2½ deg. with the axis. The losses were measured by water manometers connected to ⅛-in. nipples tapped into the lines about 6 in. before and after the meters. The losses were found to vary approximately with the differential head:

Size of Meter, In.	Loss of Diff. Head Per Cent	Compressed Air — Press Lb. Abs.	Compressed Air — Temp. 0 Deg. F.	Pounds Loss Per Sq.In. for 1 Ft. Diff.
10 x 5	18	21.5	86	.078
5 x 2	22	22.0	80	.095
4 x 2	21	18.7	86	.091
3 x ¾	24	21.5	78	.104

The results indicate that the losses are higher in a small meter than in a large one for the same differential head. The greater loss in the smaller tube is due to the higher friction loss. In most designs the air would pass through two meters, the main air meter and a smaller meter for the tank where the air is used.

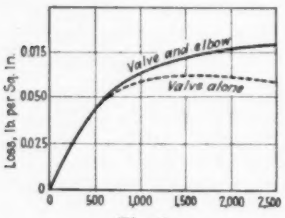


Fig. 2

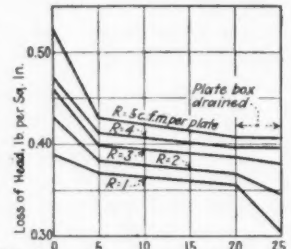


Fig. 3

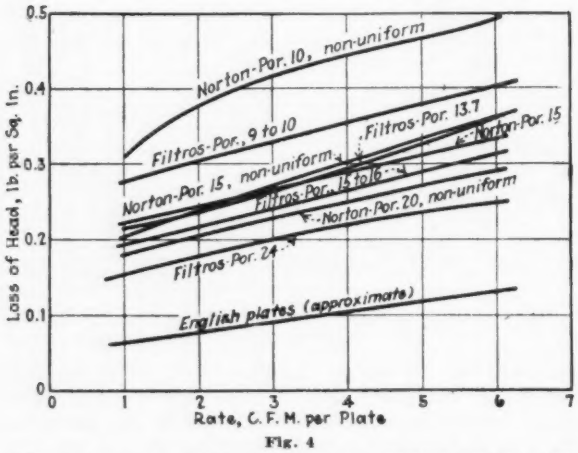


Fig. 4

FIGS. 2, 3 AND 4—LOSS OF HEAD IN CHECK VALVE AND THROUGH AERATION PLATES

Fig. 2—Loss of air-pressure head in 10-in. check valve. Fig. 3—Loss of head through aeration plates, with plate boxes drained. Fig. 4—Loss of head through aeration plates with plate box full at start and constant head for 20 min., then drained. All tests made under water head of 14.5 ft. and with free air at 14.7 lb. per square inch absolute at 62 deg. F.

Meters should be selected to give the minimum differential head consistent with accurate readings. To keep down the loss it is desirable to keep the differential head in a Venturi air meter less than a foot of water, and for most types of recorders the accuracy is not good for differentials less than an inch of water. Differential heads between a foot and an inch give a ratio of maximum to minimum air flow of 3.5 to 1.0. By properly selecting the meter tubes the total loss in two tubes could be kept to 0.1 lb. per square inch.

Loss of Head in Check Valves—The loss of head through a 10-in. check valve was measured at the DesPlaines sewage-works. The valve used was one with an aluminum flap. As it was immediately followed by a standard flanged elbow, it was necessary to include the loss through the elbow. The taps for measuring the loss were taken 4 in. before the check valve and 4 ft. 10 in. beyond the face of the elbow. The observed losses are shown in Fig. 2. The losses through the check valve alone were determined by assuming 30 diameters of straight pipe for the elbow and subtracting the loss as determined from the 10-in. cast-iron pipe. The loss through the check valve is very high. In an activated-sludge plant the air might pass through two check valves, one immediately following the blower and one just before the aeration tank. At DesPlaines the total loss through check valves would amount to nearly 0.15 lb. per square inch.

Loss of Head in Aeration Plates—Tests were made at the Tannery testing station to determine the loss of head through aeration plates. Plates made by three different manufacturers were tested. The Filtros plates were made by the General Filtration Co., of Rochester, N. Y., the Norton plates were manufactured by the Norton Co., Worcester, Mass., and the English plates were manufactured by Activated Sludge, Ltd., London, England.

The filtros plates are made of silicon sand bonded by a silicate and kiln burned at a high temperature; the Norton plates are of crystalline fused aluminum bonded with a high aluminum glass and kiln burned; the English plates are made by a secret process but are "neither baked nor fired." The English plates were about 10 in. square and came in cast-iron containers. Each plate had a ¾-in. air inlet at its center. The other plates were 12 in. square and were grouted into concrete boxes. Each plate box contained five plates and was equipped with a 1½-in. air inlet and a 1-in. drain. The boxes were placed at the bottom of a tank about 15 ft. deep, filled with water. The depth of water over the top of the plates was 14.5 ft.

The air rates were measured by a 3x¾-in. Venturi meter with a water manometer calibrated to read cubic feet per minute free air at 14.7 lb. per square inch absolute pressure and 60 deg. F. The pressures at the meter and under the plates were measured with mercury manometers. The loss of head through the plates was obtained by subtracting the depth of water over the plates from the pressure under the plates.

Some tests on loss of head were made with the same plates when the water was not drained from under the plates. Starting with an undrained plate box and keeping the rate constant, a very material drop in pressure under the plates was noted and at the end of 20 minutes the loss was very nearly equal to that of the drained plate box for a similar rate per plate (Fig. 4).

Aeration plates after being in operation for a considerable length of time must tend to clog, thus slowly increasing the loss of head through them. Therefore, for purposes of design, a factor of safety should be applied as found by experiment, to fit local conditions. Plates may clog on the lower side from rust, oil or dirt although it was found at one of the Sanitary District's testing stations that soot from a railroad roundhouse did not clog plates. Such losses can be kept at a minimum by filtering and washing the air, taking care that the blowers do not leak oil into the lines and using galvanized or cast-iron air piping and plate box fittings. Plates may clog on the upper surface from deposits of sand, sludge or possibly in treating a caustic liquor from the formation of calcium carbonate either in or on the plates.

New Data on Railway Bridge and Building Work

Abstracts of Papers at Recent Convention of American Bridge and Building Association at Kansas City—Rebuilding Columbia River Bridge—Eads Bridge, 1824-1924—Paint Inspection

Rebuilding Columbia River Bridge: U. P. Ry.

By G. H. Trout
Bridge Engineer, Union Pacific System

IN REPLACING a ten-span wooden Howe truss bridge carrying the Union Pacific Ry. (O.-W. Ry. & N. Co. Line) over the Columbia River near Kennewick, Wash., new piers were built between the old ones and the old spans were used as falsework for the new steel spans. This method of reconstruction was made practicable by diverting traffic over another route. The old bridge had nine 150-ft. fixed spans and a 240-ft. swing span, while the new one has three spans of 242 ft., three of 192 ft., a 280-ft. swing span and three 90-ft. girder spans. All of these are through spans and at each end is a pile trestle approach.

To enable the new floor system to be built at the same level as in the old bridge, the Howe truss spans were lowered about 2 ft. The old top lateral bracing was removed, timbers being laid across the trusses to hold them in position without interfering with steel erection. Short timbers bolted to the top chords held the steel web members in position until the steel top chords were placed. One line of new trusses was placed outside the old trusses, supported at each panel point by an outrigger of two 14 x 28-in. timbers laid across the wooden bottom chord and having a projection of about 6 ft. The other line of new trusses was inside the corresponding old trusses. After the trusses of the three spans on one side of the draw had been completed, the derrick car used in erection worked backward to remove the old floor, being followed by a locomotive crane which put in the new floorbeams and stringers. Similar methods were used for the other three spans. While rebuilding the floor, the outriggers were placed below the bottom chords of the old trusses and anchored to the steel spans, in order to carry the former while they were dismantled. Finally, the new spans were lowered to their seats on the new piers.

Special arrangements were required at the draw, as the old and new spans interfered. At the east end of the old swing span three panels were cut off and a counterweight added to balance the longer arm. The east arm of the new draw was then erected as a cantilever, first to the old pivot pier and then to the new end pier. The substructure work was done by the Missouri Valley Bridge & Iron Co.; erection of the new superstructure and removal of the old trusses and piers was done by company forces, all work being under the direction of the engineering department of the Union Pacific Ry.

* * *

The Eads Bridge: 1874-1924

By C. E. Smith
Consulting Engineer, St. Louis, Mo.

IN PLANNING the great arch bridge across the Missouri River at St. Louis, opened to traffic in 1874, James B. Eads had the vision to build a double-track bridge with a separate deck for a 42-ft. highway and two sidewalks. The entire bridge was designed for a load of 6,400 lb. per lineal foot, though the heaviest locomotives of that day weighed only 2,000 lb. per foot. Today the tracks are used by locomotives and freight trains weighing 10,000 and 4,000 ft. per foot respectively, while the roadway, designed for light horse cars, carries interurban cars, automobiles and 10-ton motor trucks. The bridge is used by more than a hundred passenger trains daily. In one of Eads' reports he stated that the bridge was designed to carry a solid train of the heaviest locomotives on each track and the upper deck crowded with people; further, it would carry 28,972 tons without failing. That figures 36,000 lb. per foot and is undoubtedly a calculation from the elastic limit. The bridge would probably fail well within that limit, but it is doubtful if it has ever been loaded to more than 10,000 lb. per foot.

Each of the forty-eight arch tubes was composed of more than forty sections placed end to end and connected by couplings. Each tube consisted of a ¾-in. steel shell 18 in. in outside diameter, formed from a flat plate rolled to a cylinder and butt-riveted. In this shell were placed six staves 9 in. wide and 1 to 2 in. thick, the last stave being forced into place under heavy pressure. The staves projected beyond the ends of the shell and were grooved to engage grooves on the couplings, which were made in half circles and bolted through flanges. The sensitiveness of these arches to temperature stresses is shown by the change of 1 in. for each 25 deg. F. in the opening before the last section was inserted. Under certain conditions the temperature stresses may exceed the load stresses and there may even be tension in one or the other ring. Thus it may be seen that any section of tube can be taken out. In fact, quite a number have been taken out and replaced.

The main arch ribs and braced diagonal web system are the same as when built, except that about twenty tubes out of a total of about 1,000 have been replaced due to corrosion. The vertical supports are the same as when built, but slightly reinforced. The rod cross-bracing between the arch ribs has been replaced by riveted stiff bracing. The railroad floorbeams and stringers have been replaced and are now having plates added to strengthen them for the heaviest locomotives. The highway floorbeams are the same as when built except for replacement due to corrosion and heavier loading.

* * *

Fire Hazard of Treated Timber

By C. S. Heritage
Bridge Engineer, Kansas City Southern Ry.

BRIDGE and structural timbers, when treated, are nearly always creosoted. There seems to be an opinion prevalent that the fire hazard of creosoted timber exceeds that of untreated timber, but from what I have been able to learn this hazard is even less than for untreated timber. The dense smoke and fierce fire of burning creosoted timber give it the appearance of burning more freely, while actually less wood is being consumed and the fire is being fed largely on the oil instead of the timber. In freshly creosoted timber the surface oil is more easily ignited and the fire spreads more rapidly, but after six months to a year the more volatile oils have evaporated and the creosoted timber is much more difficult to ignite. Tests have shown an average time of ignition of 5 min. 4 sec. and 2 min. 4 sec. for creosoted and untreated blocks; the average time of burning was 23 min. 36 sec. and 20 min. 8 sec. respectively, while the percentage of timber consumed was 21.7 and 32.76 for the creosoted and untreated blocks respectively.

When a creosoted ballasted-deck trestle on the Nashville, Chattanooga & St. Louis Ry. was ignited in 1921 there was a fierce fire which burned for 2½ hours, but the timbers were only charred for ½ to ¾ in. and only a few sway-braces needed renewal. Traffic was resumed without awaiting repairs and these repairs cost only $75. It was evident that the fire smothered itself, the creosoted oil leaving a residue which accumulated on the surface and excluded the oxygen. This trestle is still in service with no further repairs. After a similar fire on the Southern Pacific in 1922, only a few panels were renewed; the timber was charred to a depth of 1 to 1¼ in. No doubt the ballasted decks on these structures offered considerable protection. On the Kansas City Southern Ry., some open-deck bridges of creosoted timber have been almost entirely consumed, while others have sustained comparatively little damage. At the Poteau River bridge, untreated piles were

practically consumed, but creosoted piles suffered much less damage and were used in rebuilding.

Creosoted structures should have sand boxes at intervals, dry sand being more effective than water in extinguishing small fires. Long trestles should have fire barriers composed of a few panels of concrete trestle or a concrete pier extending beyond the width of the trestle. It is desirable also to divide such trestles by filling a few panels at intervals. Timber roadways on steel bridges should be designed to retard fire. Creosoted blocks on a concrete base are practically fireproof. With blocks on timbers or plank on stringers, the spaces between stringers over the floorbeams should be blocked to prevent a draft and to retard the spread of fire under the floor. On long wharves and docks, fire walls at suitable intervals should extend down to a low-water point.

Committee Reports

Placing Concrete in Winter—Knowledge of concrete and methods of placing it have grown so that concrete can be placed irrespective of temperature. A culvert on the Canadian National Ry. was built successfully when the range was from 20 deg. above to 53 deg. below zero. At such low temperatures the cost of protection is high and the work ordinarily would not be undertaken, but this instance shows the practicability of winter work. A study of temperature records of northern cities shows that in most cases the spells of severely cold weather are short and that on a great majority of days the temperature during working hours is little if at all below the freezing point. It is hardly advisable to stop work for several months because of the possibility of a few short spells of very cold weather. The real reason for the winter shutdown appears to be a matter of custom.

The following conclusions are presented: (1) Concrete can be placed regardless of temperature if proper methods are used; (2) where temperatures seldom fall to zero, concrete can be placed efficiently and economically all through the winter, with only a few interruptions due to severe weather; (3) the extra cost of protecting concrete in cold weather on railway work is usually less than 5 per cent; (4) the economies of winter work due to lower prices, more efficient labor and freedom from material delays usually offset the cost of protection and may show a net saving; (5) the advantages of better distribution of traffic, less interference with operation, continuity of employment, improved morale, better supervision, possible lower construction costs, and earlier use of needed improvements, make a 12-month program of concrete work highly desirable.

Gasoline and Electric Pumping—For railway water stations, electrically-driven pumps are the more reliable and by far the most economical to operate and maintain where it is practicable to install them. Because of the ease of operation the man in charge will attend to the pumping more promptly. Where an electric pump can work automatically this is the most desirable way. At a plant where a gasoline engine was used for a daily supply of 36,000 gal. the average cost of operation and maintenance was $47.66 per month. When a change was made to a 3-hp. electric motor the cost was about $8.50. Similar results cannot always be obtained and it is not always practicable to install motors. There is a hazard in that the supply of current may fail, but the plant mentioned has never been thus inconvenienced.

Inspection of Painted Work—Some roads employ bridge inspectors who make much more detailed examinations of the bridges than can be carried out by the division inspection parties, which cover many miles of line in a day. In the minute study of all parts of a steel span the inspectors are able to obtain a much more complete knowledge of the condition of the paint, especially on those parts not readily accessible. Railroads that maintain this inspection service justify it by the more complete records of the physical condition of their bridges which it affords, not only as to the metal but also as to the condition of the paint and the service obtained from the paint. The railways may well give consideration to a further extension of this idea through the employment of district or system inspectors of building painting, if not also of bridge painting.

The inspector should report to the chief engineer, engineer of maintenance-of-way or engineer of structures. He should be selected with due consideration of his knowledge of paints and painting workmanship, his ability to analyze the results of his findings and an aptitude for effective co-operation with the line officers of the maintenance-of-way department. If the territory to be covered exceeds more than two or three thousand miles of line he should be provided with one or more assistants.

While in the main he would devote his time and energies to a study of the service being obtained with various brands of paint, based on the development of a complete record of paint performance, he would also be required to observe the manner in which the painting is being done. In general, his duties would include frequent visits to the paint gangs, annual inspections of all painted structures in his territory and the conduct of such tests or special investigations as he might find advisable in considering the use of new materials.

Smokejacks for Roundhouses—Increase in size of locomotives has necessitated increased size of smokejacks and it appears that the area of the jack flue should be about 10 per cent of the grate area of the largest engine using the roundhouse. Dampers and caps to check loss of heat through smokejacks not in use are likely to get little attention. All types of jacks, except those made of concrete, are suspended from the roof framing, which must be designed to carry the weight, averaging 1,520 lb. for wood, 1,500 lb. for transite, 5,400 lb. for cast iron and somewhat more for concrete. The wood jacks now used are quite different from the old home-made jacks, being made from laminated planks built up of 2x2-in. strips of redwood or fir. In the finished piece all strips are vertical. Experimental jacks of concrete have given good service, but the experience on one road is that it takes considerable time to warm them and until this is done they do not draw well.

Small Open Caissons Used in Water-Bearing Material

Two Types of Caissons Used—Level of Water Table Lowered by Pumping—Diver Used To Excavate Sumps

MODIFICATIONS of the method of building foundations by means of small concrete caissons sunk from the surface by the combination of their own weight and the weight of material backfilled upon them, a method used in sinking the foundation of the First National Bank Building in Boston, have been used in sinking the foundations of a small apartment house on Commonwealth Ave. in Boston.

Conditions at the apartment house site are similar to those at the bank building site, a porous, water-bearing material, overlying a thick bed of gravel of sufficient bearing value to carry the foundation. At the apartment house site this firm material was encountered at a depth of about 27 ft. Originally it was the bottom of part of Back Bay and is covered with a few inches of fine silt above which are coarse sand and heavy gravel placed by train-filling when the region was reclaimed.

Water was encountered about 10 ft. below the surface in such quantities as to make it appear at first that pneumatic methods would have to be used.

The type of foundation determined upon was similar to that used in the bank building, a type patented by the Charles R. Dow Co. and described in *Engineering News-Record* March 29, 1923, p. 577. It consists of a number of cylindrical concrete piers with spread bases, the latter being either circular or rectangular in form. The piers with circular bases are put down by sinking sections of steel cylinders 8 ft. long—each section being of slightly smaller diameter than the one above—

until within a few feet of the material upon which the pier is to rest. Below that point the excavation is belled out, usually without forms, until the firm material is reached. When working in dry material the bell and shaft are immediately filled with concrete up to the top, the steel forms in the shaft being withdrawn as the concrete is filled in.

In the apartment house work it was found that the large stones in the filling material made it desirable to use a larger cylinder for sinking the shaft than was required for the superimposed load. When water was reached it became evident that excavation would have to be carried on by pneumatic methods unless the water sunk to the required point they were allowed to fill with water and then sealed with concrete deposited in bottom-dump buckets. When the seal had set they were pumped out and the remaining concrete placed in the dry.

Rectangular concrete caissons were used for the piers along the back of the lot where larger footings were required on account of the cantilevers which were to carry the back wall. Details of these caissons are shown in Fig. 2. They differ from those used for the bank building in that the working shaft is a steel cylinder about 48 in. in diameter bolted to the top of the concrete caisson and calked around its lower edge

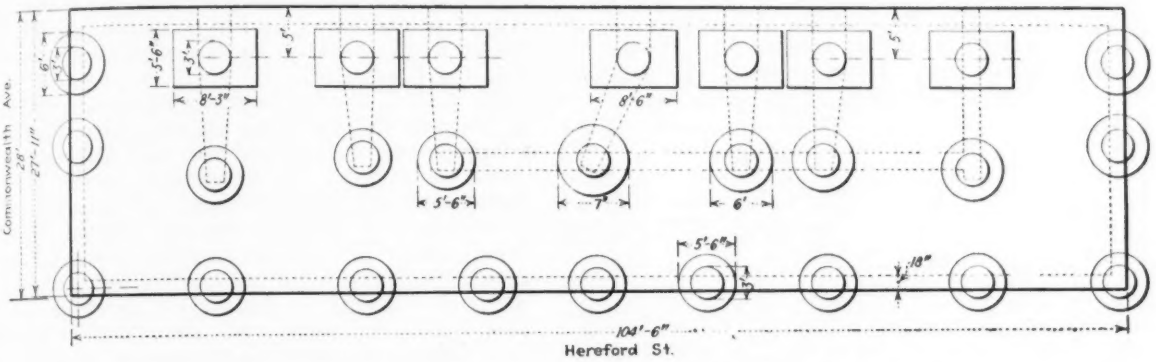


FIG. 1—FOUNDATION PLAN SHOWING LOCATION AND TYPES OF PIERS

level in the foundation area could be lowered considerably. As this seemed possible, two of the shafts were sunk to about 4 ft. below the level of the firm material upon which the foundations were to rest, using a diver to excavate them. Two pumps, one 6-in. centrifugal, and one 4-in. double-acting diaphragm pump, were put in each sump. After these pumps had been running for some little time they were able to keep the water down in the two sumps and as the work progressed it was found that excavation for the other piers could be carried on without much trouble from water. Two small pumps were able to keep down the water in the individual shafts without too much boiling under the cutting edges of the cylinder. When the piers had been to make a watertight joint. This was done because hollow concrete cylinders of sufficient diameter to admit the workmen would have been much larger in cross-section area than the superimposed load requires. During the sinking the caissons were kept in line by excavating a little faster under one side or the other.

When each caisson was sunk to the level of the firm material it was sealed in the same way as the other piers and filled with concrete up to the level of the top of the box. From this point to the surface concrete shafts 3 ft. in diameter were carried up inside of the steel shaft used for the sinking.

An interesting feature of the work was that a number of wooden piles were encountered under the footings of the old building. When these were withdrawn they were found to be in excellent condition and the lower ends were not broomed despite the coarse material through which they evidently had been driven. The only explanation of their condition was that they must have been driven with some sort of a mandrel, but how the surrounding gravel was kept in place while the mandrel was withdrawn and the pile dropped into the hole has not been satisfactorily answered.

Marden & Orlando are the general contractors for the work and the Charles R. Gow Co. has the contract for the foundation.

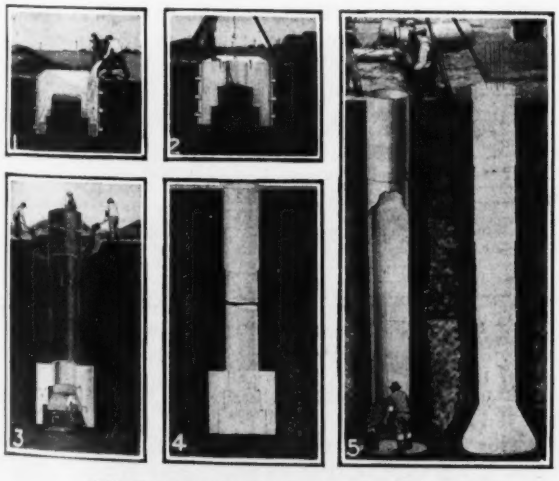


FIG. 2—METHOD OF SINKING PIERS
Showing, 1, 2, 3 and 4, method of sinking piers with rectangular caissons, 5, method of sinking piers without caissons.

Pedestrian Subways in London

Additional pedestrian subways under Trafalgar Square in London, to provide a safe crossing of the congested streets, are being built as part of the improvements to the tube station at that point. Other items in the improvements include the substitution of escalators for elevators. The escalators are being built in inclined tunnels 22 ft. 4 in. in diameter and 90 ft. long, inclined at an angle of 30 deg.

Floods and Flood Protection Projects at Wichita

Three Streams in City Complicate Problem—Four Floods and Numerous Overflows in Semi-Arid Region. Channel Improvements and Dikes; Bridges to Be Rebuilt and Raised—Rainfall Records

By P. L. Brockway
City Engineer, Wichita, Kansas

ALTHOUGH the city of Wichita, Kans., is located in a semi-arid region it has suffered from four serious floods with consequent public action for protective measures. In fact, this action was taken after the third flood, so that the engineers were able to make careful study of the most serious flood, which occurred in June, 1923. From Fig. 1 it will be seen that the city is located at the small end of a funnel, with the Arkansas River, Little Arkansas River and Chisholm Creek converging at this point, but while the first of

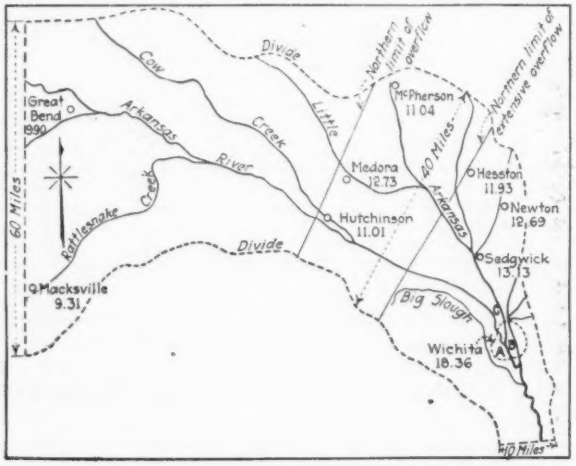


FIG. 1—DRAINAGE AREA TRIBUTARY TO WICHITA
Figures below names give rainfall for period May 21 to June 16, 1923, inclusive. River gage *A* at Douglas St. bridge, below confluence of Arkansas and Little Arkansas rivers; gage *B* at Shrine Club in Wichita; gage *C* on Little Arkansas River just north of Wichita, at Hellers Grove.

these streams is the largest it is not the most serious in flood conditions at Wichita.

The Arkansas River, having its source on the Rocky Mountain slopes in Colorado, broke into the limelight in June, 1921, by its disastrous flood at Pueblo, Colo. (*Engineering News-Record*, June 9 and 16, 1921, pp. 1008 and 1049; Sept. 28, 1922, p. 530). Below Pueblo the river continues eastward across Colorado and the western part of Kansas, then turns south to its junction with the Canadian River in Oklahoma. The Arkansas River has a considerable drainage area in southeastern Colorado, but this is an area of very low rainfall and contributes little to the flow. On the other hand, irrigation projects divert a considerable portion of the water from the river into this area.

The eastern slope of Colorado is relatively steep, changing somewhat abruptly near the Kansas boundary; beyond which there has been a long continued cumulative building up of the river bed by deposition of detritus, consisting almost exclusively of quartz and granite sand and gravel of mountain origin. In periods of extreme low water the winds blow out the finer particles into sand dunes along the banks, in which willows, cottonwoods and other hardy shrubs take root. Sand bars similarly become green islets, which in turn catch drift and more sand and silt in each freshet, so that river bed, banks, bars and islands are all built up together. There is evidence that in the past the river has broken over its low banks and wandered back and forth across considerable territory. At the present time, there is a large underground storage of water in these sand and gravel beds in Kansas, which is being developed for irrigation by means of large low-head centrifugal pumps.

For most of the distance across Kansas the river bed is so shallow that the water will reach flood stage with a rise of four to seven feet and when it overflows it cannot return to the river for several miles. In fact, near Great Bend, which is literally at the middle of a great bend to the north in the river channel, the land slopes directly away to the south for fifty miles, this slope beginning within a few hundred feet of the river bank. It is a matter for serious speculation as to what will happen before many years in some unusual flood, considering that the 1921 flood deposited several feet of gravel in what was a comparatively deep channel near this point. This rather unique river elevation prevents any tributaries from flowing into it and also provides immense reservoir capacity in adjacent low lands, so that even the Pueblo flood of 1921 caused only nominal damage in Oklahoma.

Wichita is located on the river about fifty miles north of the Oklahoma line. At a gaging station established by the U. S. Geological Survey just as the 1921 flood approached there was recorded a maximum flow of about 8,000 sec.-ft. with an extreme rise of 6.5 ft. This rise did not cause any overflow in the city, as long continued commercial sand pumping has lowered the river bed a maximum of 7 ft. at about 2½ miles below the gaging station, increasing the slope above and reducing it below, as shown by the profile, Fig. 2. At this point the river rose a maximum of 8.6 ft. in 1921. The cross-section at maximum stage at the gage of the U. S. Geological Survey was 18 per cent less than at the U. S. Weather Bureau gage (see Fig. 2), although at the lower point the flow was approximately 10 per cent greater because of flow from the Little

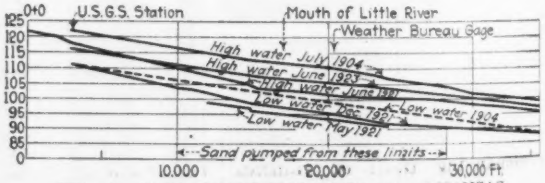


FIG. 2—SUCCESSIVE PROFILES IN ARKANSAS RIVER AT WICHITA

Arkansas River located as shown in the drainage map f the city, Fig. 3.

This detailed discussion of the Arkansas River has been given to show that its flood water is not the major problem confronting Wichita and the adjacent territory, in spite of the fact that on the map it looks by far the most important stream. Conditions obtaining above

Great Bend may be disregarded. Nevertheless, Wichita has been visited by four serious floods besides numerous minor overflows. These were prevented from becoming disasters by the fact that the valley is six to eight miles wide with only a few feet difference in elevation in any profile normal to the river.

Floods and Rainfall—In 1877, when Wichita was a village, the water extended from hill to hill across the valley. In 1904, boats were in common use over the city and in lower places the water would "swim a horse." In 1916 a large area in the north part of the city was flooded. As this included the industrial area the damage was heavy and there developed a strong sentiment for flood prevention work. After various false starts a drainage district was organized, partly within and partly without the city, and engineers were engaged just in time for them to make observations of the serious flood in June, 1923.

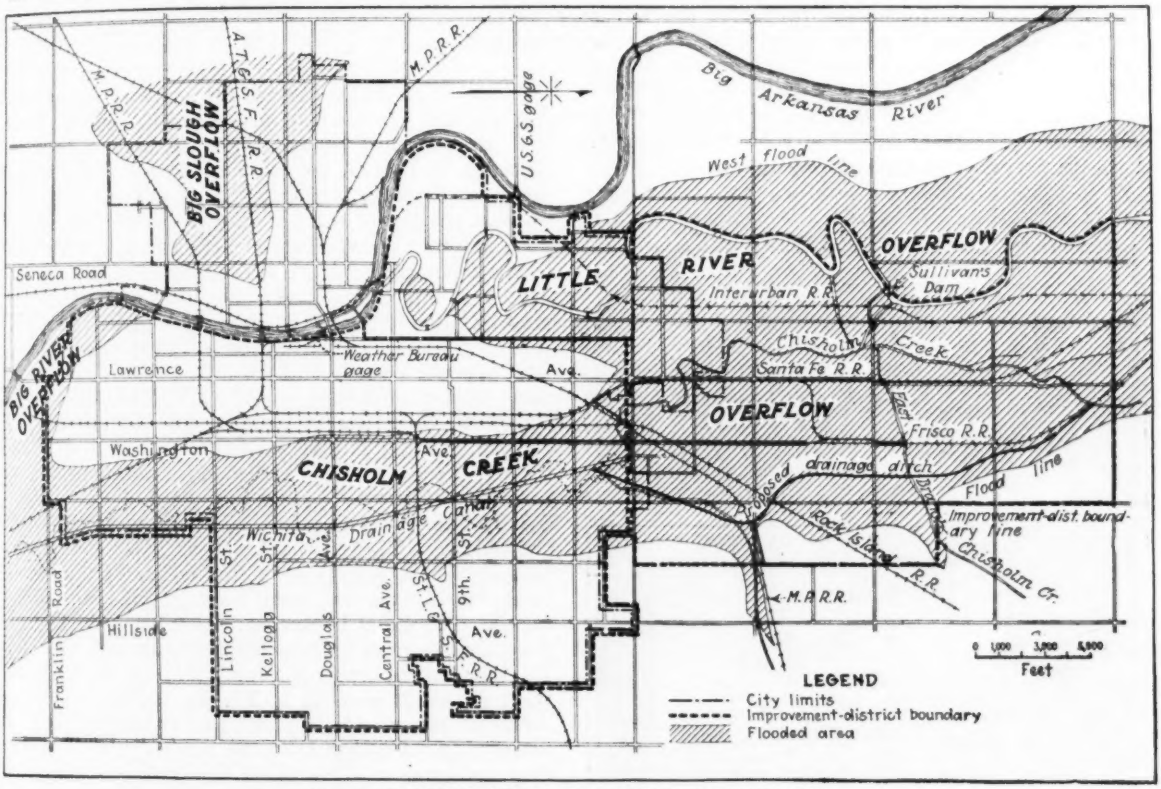


FIG. 3—FLOODED AREAS OF WICHITA IN JUNE, 1923

On the map, Fig. 1, is shown the total rainfall at various observation points for the period included between May 21 and June 16, 1923. The normal rainfall for this period is 3.5 to 5 in., while the annual normal rainfall is about 30 in. Having this in mind, the accompanying table of rainfall and resulting river stages is interesting in showing what can happen over a considerable area in a region which is popularly supposed to be semi-arid. It is also pertinent to note that from two to four inches fell in the twenty days preceding the tabulated information.

Flood of June, 1923—On June 8, 1923, when the soil in the whole area was fully saturated, there came a general rain of 2 to 5 in., most of it falling in the late afternoon and early evening. Reports indicated that not less than 4 in. fell over the 65 sq.mi. of drainage area of Chisholm Creek, largely in rough hilly country along the east side of the valley. Careful measurements made before the water subsided showed that various branches of the stream were carrying a maximum runoff of nearly 0.2 sec.ft. per acre or a total flow of about 8,200 sec.-ft. Fortunately the crest in the three branches was not coincident, so that the maximum flow through the city was about 6,500 sec.-ft. The capacity of the artificial channel of the creek in the city was found by stream gagings to be 2,500 sec.-ft., which was further reduced to 1,300 sec.-ft. by numerous low arch bridges having clear spans of 30 ft. The stream ran a mile wide all day on June 9, with a depth of not over 4 ft. on improved streets, cutting the city in two for all transportation except horse-drawn drays.

By the evening of June 9, the Little Arkansas River was overflowing into the territory north of the city, reaching a maximum flow of 12,000 sec.-ft. from its 1,200 sq.mi. of drainage area, with a channel capacity of not more than 10,000 sec.-ft. The overflow covered the territory below the line marked on the plan, flowing down into the city within a mile of the business center before a low ridge diverted it back toward the river. Extensive dikes built along this river following the 1904 flood saved the business district from flooding, although six inches more water would have topped them for at least a mile of their length.

The Arkansas River also rose to a maximum flow of 7,500 sec.-ft., making the combined flow below the mouth of the Little Arkansas about 17,000 or 18,000 sec.-ft. No damage occurred in the city from the Arkansas River, except in the extreme lower end where overflow water below the city came back about two miles.

Finally, on June 15, a local rain of nearly four inches raised the Big Slough (flat section with a small wandering stream) to such an unprecedented height that it broke over low ridges and flooded a portion of the city which had not been under water since 1877. These flooded areas in and near the city are shown in Fig. 3.

That the Arkansas River above Great Bend does not enter into the local situation is indicated by the fact that on June 9, 1923, the river was carrying 7,400 sec.-ft. into Kansas, which was decreased to 2,400 sec.-ft. as the crest passed down the river before it reached Great Bend. On June 18, a flood of 14,300 sec.-ft. was reduced similarly to 8,700 sec.-ft. Then on Aug. 23, a crest of 18,000 sec.-ft. passed the Kansas line but was reduced to 5,000 sec.-ft. when it reached Wichita. Typical views of the June flood conditions are shown in Fig. 4; at this point motor traffic was able to continue under difficulties. Flood water was continuous for 1½ miles on this street but did not come above the first floor of any dwellings.

As to property damage, a careful survey made immediately after the flood indicated that 97,000 acres of

FIG. 4—WICHITA IN FLOOD OF JUNE, 1923

farm land were flooded within the area shown in Fig. 1, with an estimated crop damage of $942,000. Damages to bridges and highways, $95,000; railroads, $335,000; industries and dwellings in 12 sq.mi. flooded in and adjacent to the city, $840,000; making a total of $2,212,000. This estimate is made by S. P. Peterson, meteorologist in local charge of the work of the weather bureau. A similar survey by Clark E. Jacoby, engineer commissioner for the drainage district, showed damages as follows: On 97,000 acres of farm land from Wichita to Halsted, $100,000; growing crops on same area, $942,000; city of Wichita, including public and private property, $920,000; industrial property adjacent to Wichita, including railroads, $443,000; total, $2,405,000. These independent reports agree within reasonable limits, when it is considered that thousands of individual owners sustained immediate losses varying from fifty to a few hundred dollars and many could only estimate the ultimate damage to their property.

Flood of September, 1923—A second flood, in the Little Arkansas River basin only, occurred in September, 1923. Records indicate that the rain fell on most of the drainage area, with a maximum of 9 in. at the center of the storm area. Stations within twenty-five miles of this point recorded less than one inch. It is believed that all of the rain fell in a few hours. The

RAINFALL AND RIVER STAGES: ARKANSAS VALLEY
RAINFALL RECORD JUNE, 1923

Stations	19-Days May 21—June 8 In.	24-Hours June 9 In.	7-Days June 10—16 In.	Total for 27 Days In.	Normal for 27 Days In.
Wichita	6.37	6.88	5.11	18.36	4.73
Sedgwick	4.49	5.30	3.34	13.13	
Newton	4.14	5.75	2.80	12.69	4.40
Hesston	3.66	4.06	4.21	11.93	
McPherson	5.88	1.70	3.46	11.04	4.55
Medora	7.32	2.77	2.64	12.73	
Hutchinson	7.37	1.64	2.00	11.01	3.67
Great Bend	8.07	0.64	1.19	9.90	3.35
Macksville	6.31	1.40	1.60	9.31	

tributary creek which drained the area of greatest rainfall intensity, rose to an unprecedented height, while the river reached stages almost identical with those recorded in June at points near the north end of the proposed drainage district. Since the other streams were at low stages and not affected by the rainfall, the flood flattened out and caused little damage in Wichita.

The following report of the damage, compiled by Mr. Jacoby, is interesting in showing what a single rainfall may do in a territory largely agricultural and in a relatively small area: Damage to 10,000 acres of farm land between Wichita and Halsted, $15,000; to crops in same location, $14,000; to city of Wichita, $24,000; to Sedgwick, $100,000; to Newton, $60,000; to Halsted, $50,000, making a total of $263,000. This does not include damage to roads and bridges, which must have been $50,000 more.

It is interesting to note that at Arkansas City, near the Oklahoma line, on the Arkansas River at the junction of two other tributaries, the estimated total maximum flow during the June flood in 1923 was 80,000 sec.-ft. The valley is narrow at this point also and the flood damage was correspondingly more intense. The Weather Bureau report for June, 1923, places the loss in the three south counties in Kansas, through which the Arkansas River and its immediate tributaries flow, at $12,652,750. Quoting from the report: "At Arkansas City the water rose five to six feet higher than in 1904 and, according to recollection of old residents, exceeded the flood of 1877." Two lives were lost, and the loss to city real estate was officially estimated at $7,240,000, a real disaster in a city of about 10,000 people.

Flood Protection Measures—As a result of these losses, various rural and urban communities along the Arkansas River are organizing or have organized drainage districts for minimizing flood damage. Most of the rural districts contemplate minor expenditures of money for dikes at the lowest banks and small ditches to drain off low depressions more rapidly. An attempt has been made to organize a general continuity of effort along the river.

For Wichita, where the plans are on a larger scale because of property interests involved, the following studies have been made and conclusions reached. An attempt was made to forecast frequency, intensity and seasonal occurrence of unusual rainfalls, but the records of any one station do not cover more than thirty-five years, which is too short a period. Stations also are too far apart to give conclusive evidence, because of the wide variation in rainfall within a few miles. It is known, however, that in this general territory,

rainfall of as much as 11.25 in. has fallen in one spot in twenty-four hours. Other studies made from long records and over large areas indicate that rainfalls of this intensity seldom cover more than a township and that their occurrence in any one locality is very infrequent. It is also known that such rainfalls do occur and of course may occur at any time.

In June, 1923, Chisholm Creek, with 65 sq.mi. of drainage area, discharged 6,500 to 8,000 sec.-ft. This creek will be passed around the actual and potential industrial district by a canal having this capacity. The Little Arkansas River will be cleared of débris, such as is shown in the typical view, Fig. 5, and will be enlarged and diked where necessary to a capacity of 12,500 sec.-ft. A freeboard of three to five feet will provide safety against storms even more severe than those mentioned and against possible higher water in the Arkansas River raising the flood plane of the Little Arkansas flowing into it.

RIVER STAGES JUNE, 1923

Stations	Flood Stage	Dates Above Flood Stage	Crest Elev.	Date
Arkansas River:				
Wichita	9 ft.	9 to 17	13.5	10, 7 a.m.
Hutchinson	6 ft.	13	6.4	13
Great Bend	5 ft.	.....	4.5	12
Little Arkansas River:				
Sedgwick (1)	18 ft.	9 to 19	24.7	9, 5 p.m.
Hellers Grove (2)	12 ft.	9 to 17	15.2	10, 1 p.m.
Shrine Club (3)	12 ft.	10 to 13	14.3	11, 1 a.m.

1. Weather Bureau gage.
2. North Side Drainage District.
3. One mile above junction with Arkansas River.

This work is to be undertaken by the North End Drainage District, with the boundaries shown in Fig. 3, as a corporation separate from the city. Various methods of bypassing from one stream to the others were investigated, as well as possible impounding reservoir sites. The complexity of the problem was greatly increased by the fact that industrial development is already under way in the district, with many individual plans and problems. It was also necessary to provide for enlarging the waterways through the city, in order to assure adequate outlet for the waters which will be delivered at the city limits instead of being impounded in the natural reservoirs formed by the low-lying areas. Preliminary studies have been approved and approximate estimates indicate an expense of $300,000 to $400,000. This amount seems entirely justifiable when the loss from one flood in the fractionally developed district is $440,000.

The engineering department of Wichita, having all the data outlined above and being in constant touch with the development of plans for increasing the capacity of the streams entering the city, has already done some protection work and has outlined other improvements.

Improvement of Little Arkansas River—For the Little Arkansas River channel, $35,000 has been spent in hiring men and teams and organizing outfits to operate by day work in removing the most serious deposits of silt and sand and cutting back the most serious bank encroachments. It will be seen that the river flows through the city in hairpin loops, but any change in alignment of the channel is out of the question for two reasons: (1) More than half of the territory is fully developed as desirable residence districts, which would make right-of-way costs prohibitive; (2) a chain of improved city parks occupies the extreme points included between the river bends, and the river is converted into a long winding lake by a dam near its mouth. The city controls one side of the river, with the park system for two-thirds of its length in the city and with streets over most of the frontage opposite the parks. It therefore becomes merely a matter of moving earth to widen the channel to a uniform carrying capacity through this distance.

Much of the earth already moved had been deposited in the lake in flood times because sluice gates in the dam were out of commission for several years. Teams were used because most of the silt had to be moved too far for dredges to operate, there is not enough water to float heavy floating dredges and the deposits are too far out for draglines operating on the banks. In preparation for this work the lake was drained through the sluice gates, reducing the river to a small meandering stream. Cross-sections were then taken at 200-ft. intervals. It is found that flood profile does not correspond to low-water profile, so the proposed section is not constant. Dikes will not be depended upon except at lowest points, because of the menace of leakage induced by burrowing animals, the impossibility of draining off local storm water in flood stages, and the unsightly appearance of high dikes.

FIG. 5—TYPICAL CHANNEL CONDITION OF LITTLE ARKANSAS RIVER

View at low water near Sedgwick, Kan. The low banks are 6 to 8 ft. high, but the river rises 25 ft. at extreme flood stages.

The next step of improvement actually under way is the acquisition of the river bed and banks of sufficient width to smooth up the bends in the channel to easy curves and construct a roadway on each side for a distance of 1¼ miles north to the city limits. Appraisals are not completed and costs are estimated at $150,000 to $250,000. Estimates for completing the widening of the channel already under the control of the city show that about 300 trees must be removed, 110,000 cu.yd. of earth moved an average of ½-mile and 105,000 yd. moved 150 ft. This last item will probably be slip, wheeler and fresno work, because a fringe of trees left along the river side of the roadway will make dragline excavators impracticable. Contracts will be let in 1924 so that work may be completed with the lake drained in the winter months.

For the upper portion of the river in the city, resembling the view in Fig. 5, detailed plans have not been made, but the obvious first step is the removal of the trees, which are mainly elm and cottonwood. Sale of wood for fuel will pay probably half the estimated expense of $50,000.

Structures across the river include the concrete dam

already noted, the spillway of which must be increased from 160 ft. to 250 ft. in length. There is a reinforced-concrete deck girder bridge, a riveted steel truss bridge of modern type which will require an additional span, a wrought-iron truss bridge 35 years old which must be replaced, an old pin-connected high steel truss which has been extended by a pile trestle addition and four pile bridges in varying stages of preservation but all too short. Not all of these structures will be replaced at the present time. Two pile bridges have already been lengthened at nominal expense. This work will be financed by general bond issues, some of which must be authorized by elections, and require about $200,000. Calculations of channel capacity are based on known flood slopes, and channel sections using a value of 0.035 for *n* in Kutter's formula.

Improvement of Chisholm Creek.—A 7-mile drainage canal already constructed is shown in Fig. 3, replacing the original winding channel indicated by a dotted line. This new channel, in a 150-ft. right-of-way owned by the city, was dug with a bottom width of 30 ft. in the upper half and 40 ft. in the lower, with bank slopes of 1 on 1½. Below restricting bridges, successive floods have greatly enlarged the channel so that the lower two miles require little improvement.

The first step, already initiated, is to increase the right-of-way to not less than 250 ft. Surveys are just beginning. It is possible that long curves may be introduced to reduce land damage and take advantage of the possibility of including waste wooded areas along the route in the right-of-way.

Nine reinforced-concrete arch bridges over the canal are all insufficiently wide and all so low that their destruction is necessary for the passage of flood waters. The slope is very uniform, about 5 ft. per mile. A capacity of 8,000 sec.-ft. will be provided at the upper end, increasing to 10,000 at the outlet, with a freeboard of 3 ft. below the ordinary bank elevation. All bridges will be replaced with reinforced-concrete deck girder spans, having the bottoms of the girders above flood stage. From 500,000 to 600,000 yd. of earth must be moved, mostly by dragline machines. Exclusive of land damage, of which no estimate can be made, about $300,000 to $500,000 will be required on the canal work. Contracts have been awarded for renewing twelve of the bridges over the canal at a total cost of $285,000. The contracts for the remaining bridges, which will be let this winter, will not exceed $95,000.

Improvement of the Arkansas River—The Arkansas River does not require a large amount of work beyond the removal of artificial encroachments. Plans are made to give it a capacity of 20,000 sec.-ft. with a 5-ft. freeboard. In trimming banks last spring, at a cost of $10,000, it was interesting to discover a line of piling placed in the early eighties at one point coincident with the re-established bank line. Condemnation proceedings are under way along 1½ miles on the east side of the river to acquire a strip sufficiently wide for a roadway to prevent further encroachment. The city already controls the west bank from the mouth of the Little Arkansas River down to the city limits. From this point up, the water company owns considerable frontage, pumping water from the underflow; further up, the city has a park fronting the river bank to the city limits, covering 180 acres with a river-front drive. This condemnation will cost $100,000 to $150,000.

Cost Estimate—Estimated costs may be recapitulated:

North End Drainage District	$300,000 to	$400,000
Little Arkansas River:		
Land	100,000 to	150,000
Bridges and dam	200,000	
Earth moving	100,000	
Tree removal	50,000	
Canal in Chisholm Creek District:		
Earth moving and bridge removal	300,000 to	500,000
Arkansas River:		
Land	100,000 to	150,000
Land acquired	50,000	
Expended in earth moving	50,000	
Total	$1,250,000 to	$1,650,000

Damage in the one flood of June, 1923, in the same district amounted to $1,360,000. Among those actively interested are: George S. Knapp, state irrigation commissioner; Clark E. Jacoby, engineer commissioner, Kansas City; S. P. Peterson, meteorologist, U. S. Weather Bureau, Wichita; H. B. Kinnison, U. S. Geological Survey, Topeka, and M. Roseberry, county engineer, Wichita.

Length of Haul Controls Cost of Road Grading

Formulas for Fresno and Wheel Scraper Costs Computed From Field Studies—Practice of Long End Haul Needs Revision

By J. L. Harrison
Highway Engineer, U. S. Bureau of Public Roads, Washington, D. C.

Condensed from a paper in "Public Roads" for September, 1924.

OTHER factors such as the character of the soil, grades, and prevailing weather conditions, over which the designer of the road has practically no control, may operate to increase or decrease the cost of the earthwork, but the length of haul appears in general to have a more marked influence than any of these and it is an element which can be definitely controlled in advance by the designing engineer. While the study confirms the accepted practice in regard to the kind of equipment best adapted to hauls of various lengths, it appears to be well established that adaptation of equipment will not enable designing engineers or contractors to disregard distance as a primary consideration in the cost of moving subgrade materials. By showing that positive and material savings can be effected by reducing the average haul it indicates that engineers may reconsider with profit certain of the practices which are accepted as fundamental in grade location, especially the practice of balancing cuts and fills by long end or longitudinal hauls.

Basis for Studying Costs—Whenever an effort is made to determine the money cost of moving a yard of earth an astonishing number of variables appear. For these reasons, instead of using the cost in money as a basis for comparative studies, an effort was made to develop the time-distance basis. When a time-distance basis is adopted in the study of earthwork the problem is reduced to one of obtaining information as to how long it normally takes to move a unit of excavation a given distance, or, to reverse the statement, how many units of excavation can be moved over any distance in a unit of time. In the application of the data secured to estimating either by engineers or by contractors, the value of team time at any point can be determined readily enough by an examination of local rates of pay, feed costs, etc., having at all times in mind the fact that team time, as here used, includes the driver and all animals used in operating a unit of equipment. The results which have been secured by the use of this basis for study justify the impression that it will offer a ready solution for many grading problems which have in the past seemed more or less intangible.

Field Work—The first step in making these studies has been to examine going construction projects with a view toward selecting for extensive study those where the amount of cut is large enough to enable the engineers to obtain appropriate data and where the equipment is standard. When the project is determined upon, the es-

tablished practice is to select and carefully cross-section a cut. When work in this cut is begun a record is kept of the number of hours that are required in moving the material and the distance it is moved, together with other pertinent data. As often as desired while the work is in progress, new cross-sections are taken and quantities calculated. Time studies are made daily to show the average time required to make a round trip including loading and unloading, the average distance the earth is moved being determined with such care as is possible where a working outfit must be studied without being disturbed.

Formulas Developed—Translating the general time-distance graphs into mathematical formulas we have, for fresnoes,

$$t = 1.2 + 0.0101\ D$$

in which,

t = time per load in minutes, and

D = distance load is moved in feet.

The factor 0.0101 is governed by the rate at which teams have been found to move under average conditions. The constant 1.2 is the time consumed in loading, unloading, and turning.

For wheelers the formula similarly developed is

$$t = 3 + 0.0071\ D.$$

Repeated measurements made in the field indicate that the average load for normally operated fresnoes ranges from slightly over ¾ cu.yd. on short hauls to slightly under ¾ cu.yd. on long hauls. The load of the ordinary wheel scraper is found in practice to vary in about the same manner with an average of 0.4 cu.yd. per trip. The studies on the standard 1½-cu.yd. wagon operated in connection with an elevator grader are not as complete as for wheelers and fresnoes, but they indicate that wagons operated with elevator graders average about 1¼ cu.yd. per trip. Reducing the above formulas to a 1-cu.yd. basis in the light of these data, we have, then, these general formulas:

For wheel scrapers, $T = 2\frac{1}{2}\ (3 + 0.0071\ D)$

For fresnoes, $T = 3\ (1.2 + 0.0101\ D)$

in which T = time required to handle 1 cu.yd. of material.

A fresno outfit, as operated by the usual small contractor, includes the foreman (usually the subcontractor himself), the plow team with driver and plow holder, and six to eight three-mule fresno teams with drivers. The drivers customarily load and dump as well as drive. A wheel scraper outfit of this size has a foreman (generally the subcontractor), a plow team with driver and holder, a two- to three-mule team and driver, a loader, a man on the dump and from 6 to 10 two-mule wheelers. The items of supervision and plowing are so nearly the same, whether wheelers or fresnoes are used, that consideration of them may be omitted.

It therefore results that the point of equal operating cost may be obtained by equating the two formulas:

$$3\ (1.2 + 0.0101\ D) = 2\tfrac{1}{2}\ (3 + 0.10071\ D)$$

$$\text{or } D = 310 \text{ ft.}$$

The importance of this deduction lies in the fact that it shows that wheelers can not be successfully operated in competition with fresnoes except at hauls exceeding 300 to 350 ft., and therefore that lower bid prices can not be secured by resorting to the use of this type of equipment. While both on the basis of mathematical development and observed field practice it appears that fresnoes should be laid aside and wheelers used at this haul distance, contractors claim that fresno hauls as long as this are hard on the stock and so must be used sparingly. The field observations confirm this claim. Moreover, from the graph for fresno work it is a simple matter to show that the teams are under full load almost twice as many minutes per hours on a 300-ft. haul as they are on a 100-ft. haul. It therefore appears that the statement that a 300-ft. fresno haul ought not to be attempted over any extended period is sound.

The data which have been secured in regard to wagons operated in connection with elevator graders have reasonably established the fact that wagons move at about the same speed as wheel scrapers. From the limited number of studies on this type of equipment it has not yet been possible however, to derive a mathematical statement which can be equated with the formula given for the fresno and the wheeler in order thereby to develop the haul distance below which this style should be laid aside. However, enough data have been collected to warrant the statement that while an elevator grader outfit of the usual pattern handles the longer hauls as cheaply as the wheel scraper, it has not been possible to show that it is effective in so reducing costs that it is comparable with the fresno on hauls much if any below 300 ft.

Results of Study—The net result of these studies, so far as they bear on the specific problem under discussion, has been, then, to show that there appears to be no means of handling earth which eliminates as a dominant element in cost the factor of distance moved. At certain hauls a wheeler will move earth cheaper than a fresno and for the longer hauls over 300 ft. it appears probable that the elevator grader moves earth somewhat more cheaply than either of the other forms of equipment. But no form of equipment has been found in common use which enables contractors to disregard distance as a primary consideration in the cost of moving subgrade materials. The time-distance graphs make this fact very clear. In terms of fresno operation, where the movement can be kept within 75 ft., the time required may be kept within two minutes per load, while, if the movement be 300 ft., it will require slightly over four minutes. But a grading operation that takes four minutes of team time costs the contractor twice as much as an operation requiring two minutes of team time. It is not necessary to expand this statement to great length to justify the conclusion that grading costs may be reduced by a general modification in design which will reduce the haul distance.

The time-distance graphs indicate that the current practice of balancing cuts and fills by long end or longitudinal haul is expensive. Many states have so-called free-haul limits of 500 ft. or more with design practices established in accordance therewith. In those cases where the free haul is as low as 500 ft. but is calculated from center of mass to center of mass, the actual maximum haul will not infrequently run over 1,000 ft. Of course, the amount of material moved 1,000 ft. is not large but it requires almost exactly twice as long to deliver it this distance by wheeler as it does to deliver it a distance of 300 ft. At a delivery distance of 300 ft. the cost of wheeler work and fresno work is practically the same. A fresno longitudinal haul of 300 ft., in turn, takes about twice the time generally required for side borrow work. The effect of design based upon long free-haul limits on bid prices when compared in this way with short-haul work, is apparent.

Massachusetts Court Sustains Zoning Laws

By a unanimous decision the Supreme Court of Massachusetts on Oct. 18 upheld zoning by-laws of Brookline and Milton, Mass., and dismissed petitions brought to compel the town authorities to grant permits for buildings in restricted districts. The decision stands squarely on the right of the towns to exercise the police power, thus: "The police power in the reasonable exercise extends to ownership of land as well as to the enjoyment of liberty. The police power is recognized as an attribute of government. It may be put forth in any reasonable way in behalf of public health, the public morals, the public safety and, when defined with some strictness so as not to include mere expediency, the public welfare." The fact that the petitioner in the Milton case could use his land "more profitably for commercial than for residential purposes is of slight significance in the broad aspects of the case." The decision also declares that the "establishment of a strictly residential district, free from commercial or manufacturing business, may be to conserve the general health, safety and good order of the community. It cannot rightly be pronounced unreasonable. The limits of the several districts established by the zoning by-law appear to us plainly to be reasonable and not open to any well grounded objection. There is nothing about the zoning by-law which denies to the petitioner (Spector) the equal protection of the laws." Further on the court stated: "There is nothing in the record to indicate that the legal voters of Milton, in voting unanimously for the zoning by-law, were not actuated wholly by a consideration of the public welfare."

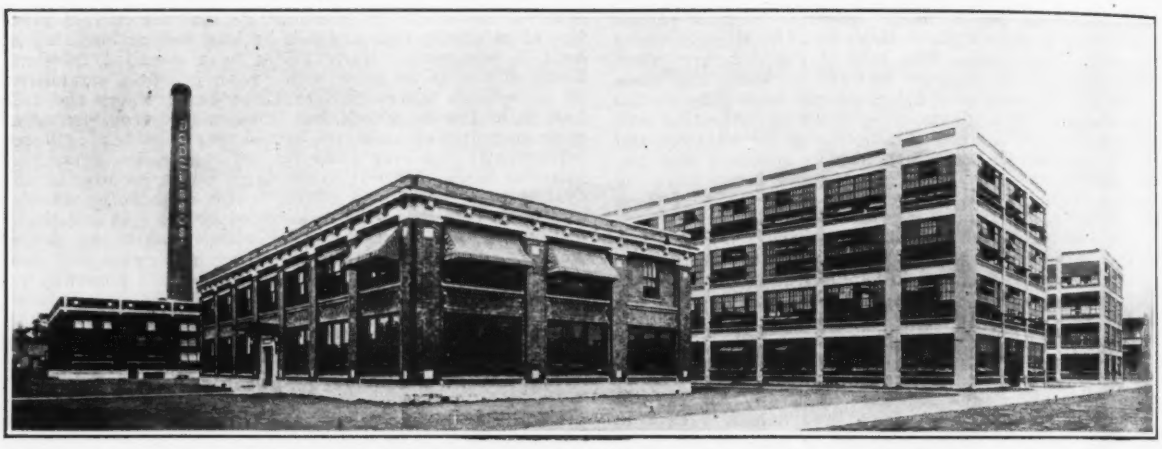
One of a Series of Articles on the Details of Design and Layout of Different Types of Industrial Buildings

Processes Affect Design of Automobile Factories

Neither Multi-Story Nor Single-Story Building Best for All Cases—Heating Easier in Former, Natural Lighting and Ventilation in Latter

By F. A. Fairbrother
Department Manager, Albert Kahn, Inc., Architects

WHEN A VAST manufacturing world develops with that rush which has characterized the growth of the automobile industry, it is natural that plants will be found which are inadequately designed for the work to be done. Many plants, in that rush, have grown in a somewhat haphazard manner; new buildings have been added without regard to sequence of operations in the manufacturing processes, other buildings being remodeled without regard to the suitability of the original construction. In truth, the design of the additions has often been governed by the need of the moment.



SINGLE AND MULTI-STORY BUILDINGS IN DODGE PLANT AT DETROIT
From left to right: Power house, administration block, two multi-story units and heat treating building.

In the automobile industry this state of affairs is also due to a great extent to the fact that the industry in the past was in a very fluid state of development. There was a constant improvement in the methods of manufacture to say nothing of the repeated changes in the design of the cars themselves. As a result of these circumstances, work is often carried out in buildings which are unsuitable for the purpose, resulting in manufacturing costs which are unwarrantably high. In modern plants these deficiencies are being eliminated as we have benefited greatly from past experiences and are better qualified to anticipate future requirements.

The preliminary study of the design of an automobile plant will immediately present the question as to whether the multi-story or the single-story type of building is to be used. The designer will realize that the cost of floor space per square foot is relatively less in the multi-story building than it is in the single-story building, and this fact will have considerable bearing on the type of building selected for the various parts of the plant.

During the early stages of the industry the single-story type of building was used almost exclusively because manufacturers were then of the opinion that machinery could not be properly installed on upper floors of buildings. And there was considerable justification for this opinion at that time, say twenty years ago, when our buildings were not constructed on principles which govern today. Then came the period when the plants developed in size, and manufacturers began to question the advisability of using single-story buildings spread over a considerable area of ground. At about this time reinforced concrete as a building material gained foothold on a commercial scale. It was found that with the use of this new material multi-story buildings could be erected which would permit the operation of machinery on the upper floors without the objectionable vibration previously experienced.

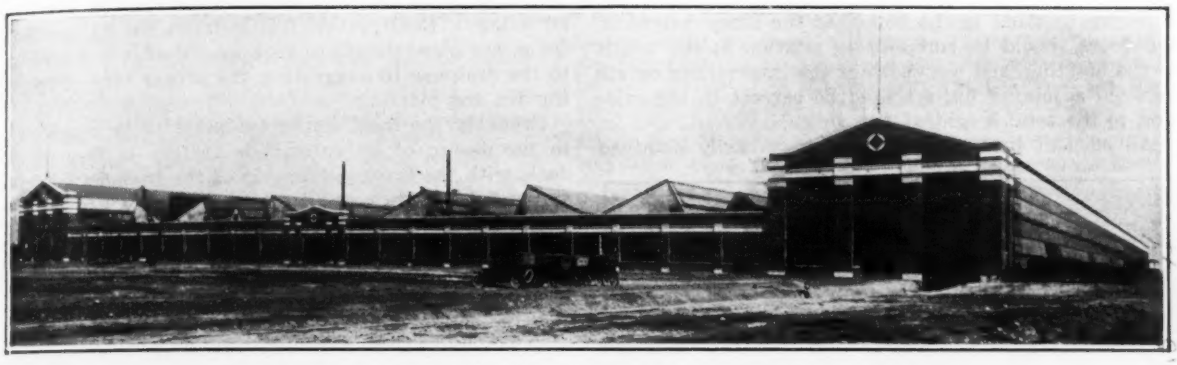
In 1903 the Packard Motor Car Co. decided to construct a new plant in Detroit and its architect, Albert Kahn, brought to the attention of the directors the new form of building material. On his recommendation reinforced concrete was adopted for the main buildings, which were designed as multi-story structures. This was one of the first, if not the first, important motor plants where multi-story buildings were used, and from that time on this type of building came into great vogue as it solved many of the problems which were presenting themselves. Since then the reinforced-concrete factory building has been looked upon with great favor and is today considered the most suitable type of construction for many purposes.

It cannot be assumed, however, that the multi-story building will answer the requirements of all the different buildings in a motor plant. Nor will the single-story building fulfill all the requirements. The most suitable type to adopt will depend upon the exigencies of the particular problem in hand.

Certain of the processes entering into the finished

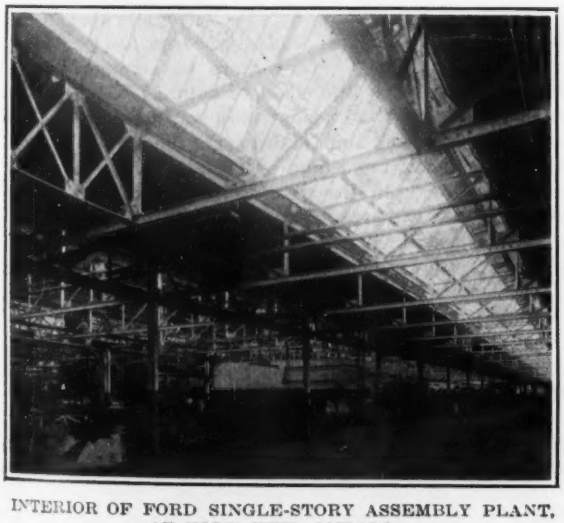
car require specialized methods of manufacture which can be carried out only in special types of buildings. In this connection might be mentioned the foundry, the forge shop, the heat treating buildings, pickling buildings and the like. As these are special buildings they will not be considered in the scope of this article.

The type of building to be adopted in general for the plant will be influenced by the nature of the product produced. In general it can be said that automobile factories are divided into three groups: (1) The factory producing a relatively small number of high-priced cars; (2) the factory producing a moderate number of medium-priced cars; (3) the factory producing a large number of low-priced cars. In addition to these main divisions, we have the further subdivisions: (a) The factory where the greater portion of the parts are manufactured and completely assembled in the one plant; (b) the factory where the parts are manufactured in one plant and assembled in another; (c) the factory which is devoted entirely to the assemblage of parts.



NEW SINGLE-STORY FORD ASSEMBLY PLANT AT FORD CITY, ONTARIO
Horizontal flow obviating intermittent elevator service seems best for assembly of heavy units. Ventilation easily controlled.

In the manufacture of small parts the cost of production is generally granted to be less if the product, during the process of manufacture, travels in a vertical plane. In such instances the process commences on the top floor of the building and is continued, step by step, to the finished stage as the material comes down to the ground floor. It is further claimed that supervision is more effective when the various departments are divided into relatively small units and superimposed upon each other, as in a multi-story building, than would be the case where the different departments are spread over a single extensive area, as in the case of the single-story building. Experience seems to prove that where small parts are manufactured and the car entirely assembled in the one plant, the buildings in the main should consist of multi-story structures. These buildings will be constructed in adjoining units separated by courts for the purpose of lighting and ventilation. The courts between the units will be covered with glass roofs, leaving the entire ground floor available for assemblage.



INTERIOR OF FORD SINGLE-STORY ASSEMBLY PLANT, AT FORD CITY, ONTARIO

As a result of late experience manufacturers are inclined to think that where the manufacture consists purely of the assemblage of parts into the whole, the single-story building will prove of most advantage. The great development of the industry has resulted in the practice of mass production with a corresponding development in the methods of transportation of the material in the course of manufacture and assemblage. These new methods consist of the conveyor and gravity systems of transportation. The operation of the conveyor system requires length and breadth of floor. The operation of the gravity system requires height, and the combination of these requirements makes it almost necessary to resort to the use of single-story buildings having a considerable story height.

Both the multi-story and the single-story factory buildings have their advantages and disadvantages. With the former, we have the problem of elevating the material from floor to floor. At best, an elevator service is intermittent and under certain conditions retards the rate of production. In the manufacture of small parts where large quantities can be packed into a relatively small space, the problem of elevation is not so serious. Where the parts are large and bulky, it is advisable that the least amount of elevator service be used. A method of hoisting material to the various floors of a multi-story building, different from the use of elevators, was adopted by the Ford Motor Co., in its Highland Park plant some few years ago. The various units of the plant, six stories high, are separated by courts which have glass roofs at the roof level of the multi-story units. Overhead cranes are used to lift the material to the various floor levels, depositing it onto cantilevered balconies projecting

from each floor into the covered court (see *Engineering Record*, Jan. 31, 1914, page 139). While this arrangement has proved very feasible, it has not entirely solved the problem of distributing the raw material to the various departments. It is probable that some such arrangement, reinforced by systems of continuous conveyors will prove the ultimate solution of the multi-story type of building.

With modern methods of construction where extensive areas of glass can be used in the wall there is little difficulty in securing sufficient daylight throughout the floors of a multi-story building. All that must be borne in mind is the fact that the story height of the floors should be sufficient in relation to the width of the building, and the width of the intervening courts between adjoining units should be correct in the relation to the total height of the units.

An efficient heating system is more easily obtained

COVERED COURT BETWEEN MULTI-STORY UNITS WITH OVERHANGING BALCONIES, FORD FACTORY

Traveling cranes deposit materials at various floor levels; some such arrangement, plus continuous conveyors, will be the ultimate solution of the multi-story building, according to the author.

in a multi-story building than it is in a single-story building spread over an extensive area. In general it will be found that the hot water heating system has much to commend itself over other systems for the former type of building. The forced hot air system is applicable to the latter type unless the building covers too great an area, in which case the hot water system will again prove more suitable.

In comparison with the multi-story building, the single-story factory has advantages in regard to natural lighting and ventilation. The large areas of glass which can be provided in the roof flood the entire floor space with natural light. The height of the building gives more cubic space per operator, and the monitors carry off the fumes, smoke and overheated air.

Considerable attention has been paid to the design of roof construction for the single-story building to produce natural ventilation, and in this respect the Lupton design has met with much favor. This design of roof construction has been found to operate well in carrying off smoke and fumes, because of the great height of the monitors. In appearance, however, the Lupton design is subject to criticism owing to the heavy trusses.

A considerable step in advancing the construction of roofs has recently been made in the various factories erected for the Ford Motor Co. In this design the monitors are supported by cantilever beams projecting from the columns and the objection to the heavy appearance of the internal truss is thereby eliminated.

As previously indicated, it should not be assumed that either the single-story building or the multi-story building can be universally used for every class of factory. Each case must be studied on its own merits and that type, or a combination of the two, should be used which fulfills the requirements to the greatest advantage. Bearing this fact in mind, the site selected for a new plant should be such as will offer no handicap to the designer in suggesting the proper type of building for the plant.

Probably the most important point to be considered in the design of an automobile factory is that which deals with the future expansion of the business. Every successful enterprise will grow and in its growth departments will not only be increased in size but entirely new departments will be added from time to time. In the preliminary study of the design, a scheme should be laid out which will provide for many years of growth. Only a sufficient portion of the original scheme need be executed to meet the immediate requirements. As the business grows, additions can be made along the lines contemplated in the original layout, and eventually the entire scheme will develop into one coherent whole. Lack of foresight in this respect is responsible for many of the disorganized plants one meets with throughout the country, plants which throw great burdens in the way of unnecessary operating expense on the shoulders of their unfortunate owners.

Redshortness in Iron

Tests and analyses to determine the effect of several impurities on the occurrence of redshortness in wrought ferrous metals have just been reported from the Bureau of Standards by J. R. Cain (Technologic Paper 261). The tests were made on electrolytic iron and on "commercially pure iron." They were so arranged as to determine separately the effect of sulphur, oxygen, copper and manganese. Redshortness was tested by bending a ½-in. bar back and forth over a blacksmith's anvil within a temperature range of 1,100 to 500 deg. C. It was concluded from the tests that (1) sulphur is the principal element responsible for redshortness and should not exceed 0.01 per cent if redshortness is to be prevented; (2) so long as the sulphur is low, oxygen is not harmful in amounts up to 0.20 per cent; (3) manganese may prevent the harmful effect of sulphur, provided the manganese amounts to three times the sulphur and provided the oxygen does not exceed 0.04 per cent; (4) manganese is less efficient when oxygen is high, say 0.10 per cent or higher; (5) copper in amounts up to 0.5 per cent has little tendency to produce redshortness, and in some of the specimens tested it tended to decrease the redshortness. The very low sulphur limit which was deduced from these tests is in sharp contrast to the much higher sulphur percentages which the tests of the Joint Committee on Sulphur and Phosphorus in Steel have indicated as unobjectionable. The work of that committee showed no noticeable change in any of the strength properties of soft steel (rivet steel) with variation of sulphur percentage up to 0.17 per cent.

How Can the Spirit of Craftsmanship Be Revived in the Building Industry?

Address by E. J. Mehren, Vice-President, McGraw-Hill Co., before New York Building Congress, Nov. 12, 1924

WE ARE gathered here today because we are troubled over the decline of the spirit of craftsmanship in the building industry. We lack craftsmen. We are cursed with a horde of contractors who have no interest in good workmanship. We see a public that is hunting bargains in buildings, or that looks on building construction solely as a speculation with quick turnover and a "get away" before the paint has worn off and disclosed the dishonest workmanship beneath.

We come here to review conditions and to consider remedies.

We seek an adequate supply of building craftsmen and a greater respect for competency throughout the industry and on the part of the general public.

We need, first, the development of more building mechanics, well trained, masters of the art of working in stone and brick and timber and metals, and of fitting them together with exactness and superior finish.

But our efforts cannot stop here. We must have foremen who themselves are craftsmen of outstanding rank. We must have superintendents, sub-contractors and general contractors who demand good work, who take a pride in what they are doing, who look on each building not as merely another structure to be thrown together and to be forgotten, but as monuments they shall cherish. We must have more architects and engineers who will battle with owners for workmanlike construction and refuse to prostitute their high callings by aiding and abetting slipshod work.

We must, finally, educate owners to the higher economic value of good work, so that they may gladly invest 15 or 20 per cent more in their building operations, confident that over the long life of the structure the additional expenditure will prove a profitable investment in lower maintenance cost, and slower depreciation.

Benefits to Be Derived—Before entering into the causes of present conditions, it will be well to consider briefly the benefits that would result from a revival of the craftsmanship spirit.

First, as to the workers. It would necessarily result in the production of superior work. It would develop in them respect for the craftsmanship of others and deter them from damaging their fellow craftsmen's work. It would secure the rendering of conscientious service. There would follow, as well, greater contentment, based on the assurance that with a wider appreciation of craftsmanship, employment would be all the more continuous and secure for those who demonstrated real ability.

Among foremen, superintendents, general and sub-contractors, architects and engineers, the revived spirit would breed a loyalty to the industry that would be a fighting barrier against the forces tending to disrupt it and to lower it in the estimation of the public. It would develop a mass attack upon the public indifference to the quality of building work.

The social results would be important and tremendously valuable. The revival of the craftsmanship spirit would stimulate the creative instinct and the desire for self-expression. It would thus tone up the outlook of the workers and be a leaven in our industrial system.

It would raise the crafts in their own and in the public's estimation. It would restore the social position of the worker, giving the true craftsman an honored standing in the community and counteracting the drift to the white collar jobs, where thousands of potential craftsmen today are inefficient and unhappy clerks and bookkeepers. The day would return when a man's proudest title was to be called a "good mechanic."

Building would come again into its own. The sons of building mechanics would not, as now, be deserting the footsteps of their fathers, and contractors who now hand down their businesses to their sons as a dubious heritage would be proud of the institutions they had built and be happy that their sons were to carry on.

Present Conditions and Their Causes—As to the conditions which exist we are all fully agreed. There is a shortage of real craftsmen in every branch of the building industry. Poor workmanship is common and there is much spoilage of the work of others through carelessness and lack of skill.

Accompanying these faults of workmanship is a rather common indifference to the interests of contractors and owners, a feeling that the worker owes them no responsibility in return for the wage he receives.

But if the worker is the one to whose derelictions we first direct our attention, he is not primarily responsible for his present attitude. He is not a free agent. He works for others and those others are chiefly responsible for his lack of craftsmanship and the spirit which accompanies it.

The parties responsible are, first, the public which demands cheap buildings, regardless of quality. The outstanding offenders are the speculative builders, the persons, be they capitalists or constructors, who build not for the purpose of owning and operating structures but of selling them at a profit as quickly as possible. They have no interest in good construction. They do not expect to hold the bag when rapid depreciation and high maintenance costs come along. By that time they expect to have their profits and to be gone. Their demand upon architects, contractors, general contractors, superintendents and foremen is for speed and cheapness, seldom or never for quality.

Another class of offender comprises the owners who want good construction, but are unwilling to pay a fair price.

Under these conditions, not merely the worker but those who supervise his activities abandon all idea of craftsmanlike performance and acquire the habit of "getting by" with the delivery of as little value as possible. From top to bottom, the incentive for good workmanship is thus destroyed.

In thus laying the primary blame on the bargain-hunting public and the speculative bidder, we cannot absolve entirely the workers. They have had serious temptation. In yielding, however, they have in many cases gone their teachers "one better." Many of them have proved adept pupils in getting good wages and delivering poor results.

The labor leaders know that this is true and have manfully fought against this dishonest attitude. Their efforts are thwarted, however, not merely by the cupidity of some of the men but by the "skinning," bonus-offering contractor.

Incompetent and dishonest contractors who are not speculators, too, must have their share of the blame. In their efforts to land jobs they bid with little or no margin, expecting to make a profit by "skinning" the job.

Conditions are, of course, much intensified by the building boom. The high wages and expectations of profits have brought into the field many incompetents, both workers and contractors, who in other times could not make a living in the building industry.

Effect of Specialization—In thus explaining the very serious conditions of recent years, we must not lose sight of the fact that the number of broadly trained mechanics has been declining steadily for a long time. This is a condition that we find throughout industry. It is due to the introduction of the quantity production system with its inevitable specialization. This has lessened the worker's interest in his occupation, has tended to destroy his pride of craft, and has had a serious influence on our whole social system. Undoubtedly, one of the problems of the times is to devise ways of lessening the deadly effects of the repetitive process, and particularly its stifling of the creative instinct and of the desire for self-expression.

The Remedies—Now let us turn to the remedies. Let us realize, first, that the task cannot be done overnight. It will be a long pull. It will be particularly difficult to make progress while the present building boom is under way.

Our method of approach might be as follows:

1. Start with the leaders, for with the leaders rests the responsibility of leadership. Start with ourselves, the Building Congress, and use architects, engineers, contractors, sub-contractors and heads of labor organizations as the nucleus from which an appreciation of craftsmanship shall spread in one direction to the worker and in the other to the general public.

If the leaders do not lead there will be no leading. Ours is the primary responsibility.

2. Be not content with merely passive admiration of

craftsmanship but adopt plans which will keep before us constantly our responsibility for encouraging craftsmen and craftsmanship.

Two sets of plans are necessary. The first will stimulate the workers, arouse their ambition and pride and convince them of the sincere interest of the leaders in good workmanship. The second will aim to convince the public that better buildings are more economical buildings and that the building industry, proud of its profession, is intent upon giving the public better and better buildings, greater and greater value for every dollar spent on building work.

Plans to Reach the Workers—In considering plans that will stimulate the workers, we must remember that we are all human and respond to the same stimuli. With one the stimulus of self-satisfaction is valid, with another the hope of making money, with another, fame.

With the direct development of self-satisfaction we have nothing to do. That must be a by-product, an ingratiating result of any efforts we put forth.

Money reward will inevitably come to the good worker, in continuous employment, if not always by a higher wage or advancement to a foreman's job. But money rewards, as part of a plan of a Building Congress must, for a variety of reasons, be set to one side.

There remains only fame—recognition and commendation of competency. This recognition can be of two kinds, a personal and private commendation of craftsmen, and, secondly, public recognition of their competence.

Private Recognition—Private recognition is the responsibility of every man in authoritative position, architects, engineers, contractors, down to and including the foremen. Construction organizations have now grown to such a size that the heads do not know their men. A worker told me recently that in ten years of employment with one company he had never seen the head of the organization. On the other hand, I know an instance where the sweetest reward that an artisan received was the thanks of the contractor for putting in what the latter declared was the finest bathroom in New York City. Knowledge of that commendation spread over the whole job and helped to improve the attitude of every worker engaged on the contract.

Public Recognition—But there should be public recognition as well. Two building congresses have taken steps in this direction.

The Building Congress of Portland, Ore., has a "Guild of Building Handicrafts." This guild selects workmen of outstanding competence, and, after examination of their work by a jury of five, awards to them, if the jury reports favorably, the title of "Guildsman." So favorably has this movement impressed the Oregon State Board of Vocational Education that it has presented the guildmen with gold buttons bearing the seal of Oregon and the legend, "Guild of Building Handicrafts." In receiving his button, at the recent formal installation ceremonies, one of the recipients made the very pertinent remark, "For forty years I have been a mechanic and this is the first time I have been honored as such."

The Philadelphia Building Congress has announced that on the first of next January it will present certificates of competence not only to workers but to architects and engineers, to contractors and sub-contractors as well. It is now gathering the records of competent men in each class and culling the names so that only those thoroughly worthy of the certificates may receive them. Certificates will be awarded in six different classes.

The owner, too, should be encouraged to show his appreciation of the care and skill that have been spent on his job. A New York banker told me recently that, had the idea been suggested, he would have been glad to erect a bronze tablet paying tribute to the artisans who had built the bank's new home. Another banker said that he would have been glad to have had all of the competent craftsmen who had worked on his structure as guests upon the completion of the job and would probably have furnished a buffet supper and some form of entertainment.

In general, craftsmen should have an honored place at all building ceremonies, at corner stone layings and dedications. We can well imagine the stimulus that would have been afforded by a proper recognition of the craftsmen at the dedication of the Lincoln Memorial. You will recall that there is precedent for so honoring craftsmen, in the legend of the feast following the dedication of Solomon's temple. The blacksmith, in his working clothes and bearing the stains of his toil, took the seat at the king's right hand and kept it under the decision of the wise Solomon when he proved that he had made the tools with which all the artisans had worked.

A handsome photograph of a building on which he had worked would be cherished by many an artisan, particularly if it bore a statement that it had been sent to him in appreciation of the skill and care he had exercised on the work.

All three of the previous devices—the methods of the Portland and Philadelphia congresses and the commendation by the owner—can be turned to capital with the public through suitable newspaper publicity. Such publicity would be instrumental in informing the public of the craftsmanship pride of the industry and of the efforts it is making to increase the value delivered for the dollars spent on building construction.

Plans to Reach the Public—There should be plans, also, as previously stated, to raise the public's appreciation of building craftsmanship. The object should be two-fold:

1. To convince the public of the competence, high character and honesty of the building industry, and

2. To impress the public with the economic value of craftsmanship.

The first purpose can be attained by giving publicity to developments and incidents in our apprenticeship work and in our plans to encourage the revival of craftsmanship.

For the second purpose, institutions and large corporations finishing fine new buildings should be persuaded to invite the public to visit their structures as an evidence of their pride in the craftsmanlike job they have secured.

Banks, for example, in extending such an invitation could readily be persuaded to explain in their newspaper advertising that they could have secured mere housing for a lower price, but that they were building for permanence and that besides having given them a handsome home, the additional expenditure would result in long-time economy.

As further means of impressing upon the public the economic value of good workmanship a pamphlet, brief and illuminated by dollars and cents arguments, setting forth the economics of maintenance costs and depreciation, might be made available for distribution by architects, contractors and sub-contractors.

Value of Apprenticeship—Finally, our own apprenticeship system, in assuring a thorough training, will develop in the young men a pride in their calling. A movement for the revival of the craftsmanship spirit could have no stronger right arm than a strong apprenticeship system.

The dignified commencement ceremony at the conclusion of the apprenticeship course is, also, a means of indicating to the young men the honor that the public attaches to competence and the dignity with which it invests the crafts.

Psychology of Clothes—But while we thus indulge in thoughts of improvement, let us not blind ourselves to conditions that work against us.

We want to revive the spirit of craftsmanship. The true craftsman has a high respect for his ability and for the calling in which he is engaged. In fact, without self-respect he could not be a craftsman.

Therefore, we want these men to develop a high self-respect. But at the same time we provide working conditions that cause them constantly to violate their self-respect.

In these days a good deal of attention is paid to clothes. No one wants to go into a well-clad gathering ill dressed, unshaven or unwashed. Self-respect keeps one from doing so. Yet we ask our mechanics on building operations to go to and from work in "working clothes." We do not supply facilities for the proper storing of good clothing during working hours, nor adequate facilities for washing up, so that the men may go home on surface car, elevated, or subway feeling as important as their neighbors.

Shall we not neutralize our efforts to revive the spirit of craftsmanship if we allow this condition, detrimental to the self-respect of the worker, to continue? I do not propose to argue the question. I know that there are difficulties. But I throw out the suggestion that we cannot honestly advocate the revival of craftsmanship, which means the development of self-respect, and at the same time continue to maintain conditions which work against that self-respect.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

An Author's Comment on a Review

Sir—In the review of Sections IV and V of my Elasticity and Strength of Materials Used in Engineering Construction, in your issue of Oct. 16, p. 639, you write of conventional and unconventional methods of treating mechanical questions as though the terms would convey precise meanings to your readers. I submit the following comment:

By experiment a pipe strut with ball-and-socket ends and a slenderness ratio of $140\,L/R$ is twice as strong as an angle with the same end bearing and slenderness ratio. Pin and ball-and-socket ends are found of the same strength with pipe struts but an angle iron with a pin end is $1\frac{3}{4}$ times as strong as one with a ball-and-socket end for the above slenderness ratio. Nevertheless, the computed strength by formulas in conventional textbooks is identically the same. Are we to understand, then, that assumed theoretical strength for the different cases is conventional when there is a hundred per cent difference as disclosed by experiment, and is it unconventional to consider the experimental results of tests to destruction of different forms of sections of the same slenderness ratio to find the reason for such divergence of strength? Is it individual opinion or a recognition of known facts which is customarily disregarded in favor of the erroneous assumption?

The manager of one of the three leading book publishers in New York complained to me that engineers were indifferent to new works on the resistance of materials. I inquired whether the new works contained practical matter not found in Rankine's Mechanics of Materials or suggested modes of computation which would bring common theory in accord with experiment not found in the older treatise. To my surprise he frankly admitted that the extent of improvement in these new books was that of more explicit statement and clearer wording for the benefit of the student. Admitting this, why should the engineer wish to add to his library that which will be of no assistance in his practical work if the same matter is covered in the same way and as concisely in the older works of original authors?

The statement that the moment of inertia in column action is four times as great as in simple flexure instead of being unconventional appears to the writer to be in accord with customary analysis. Thus, if it is pure flexure, for equal tension and compressive stresses on opposite sides of a rectangular section the moment of inertia is $bd^3/12$; if it be all compression on one side and zero stress on the other, it is $bd^3/3$. The amount of bending is therefore a function of the stress area and the moment of inertia which pertains thereto. This may be illustrated by an experiment with cubical wood blocks. A string of these may be pushed against the wall and if not too long will support a couple of Indian clubs as long as the pressure is applied at the end. When the string gets too long it buckles—illustrating the point.

It may be suggested that the explanation of the difference between the static and kinetic moduli of elasticity in Section I of the series might clear up the matter which the reviewer regards as a fog of words in the treatment of impact as he would not expect the writer to develop elementary principles in the first section and explain them again in a following section.

Minneapolis, Minn., Oct. 21, 1924. C. A. P. TURNER.

Ketchum's Handbook Revised

REVIEWED BY JOHN C. MOSES

Engineer of Construction, The Boston Bridge Works, Boston, Mass.

STRUCTURAL ENGINEERS' HANDBOOK; Data for the Design and Construction of Steel Bridges and Buildings—By Milo S. Ketchum, C.E., M. Am. Soc. C. E., Dean of College of Engineering and Director of Engineering Experiment Station, University of Illinois; Consulting Engineer. [Third Edition, Enlarged.] New York and London: McGraw-Hill Book Co., Inc. Flexible; 7 x 9 in.; pp. 1065; many line drawings; 176 structural tables. $7.

The usefulness of this handbook is well attested by the large sale it has had during the ten years that have elapsed since its original publication. A second edition in 1918 made some changes and additions in the chapters that treat of Mill Buildings and Highway Bridges. In the third edition, the subject of this review, we have a book that has been revised and partially rewritten, with the addition of much new material.

For the benefit of those not already familiar with the book, something should first be said of its purpose and contents. The author plans it as a manual for the engineer and draftsman engaged in the design of structural steel buildings and bridges of moderate span, not including movable, suspension or cantilever types. Bins, standpipes, stacks, grain elevators and mining structures are given considerable space, because not ordinarily covered by textbooks. Drafting, estimating, inspection and erection are the subjects of separate chapters, and are followed by others on engineering materials, structural mechanics, and the design of details. There are numerous illustrations of actual structures, and many of the specifications prepared by the A. R. E. A., A. S. T. M., and by the author himself, are given in full. The last third of the volume contains most of the tables found in the Carnegie and Bethlehem handbooks; and also many prepared by the author, giving the properties of compound sections and other data for the designer. Much material is brought together from many sources, and it is made readily available by a full table of contents and a good index. References are given for the use of those desiring fuller information on any of the subjects considered. The book is well arranged and excellently printed.

A book of this character will evidently need frequent revisions of portions of its contents. The specifications quoted make up about 20 per cent of the first part of the volume. These have been reprinted to agree with the latest revisions. The author has added the

Specifications for Structural Steel for Buildings, prepared by the American Institute of Steel Construction, and recent specifications of the A. R. E. A. for the Erection of Steel Railway Bridges, and for Concrete, Plain and Reinforced.

Much of the value of the book lies in its illustrations of standard practice. Here we find few changes, and are led to the reflection that little progress has been made in recent years. Is it possible that we are nearing perfection? or is it merely standardization?

The preface to the first edition gives as one of the main purposes of the book the supplying of sufficient cost data to aid in the design of economical structures, truly stating that this requires the exercise of the highest possible skill on the part of the engineer. The present edition makes no attempt to revise the data of the first edition. Where costs are given, a footnote is usually added, calling attention to the fact that "Prewar, 1914, costs are given"; and in the chapter on Estimating we read: "The costs of material and labor have been abnormal for several years, making cost data of relatively little value. Conditions are slowly returning to normal, but it is not possible at present to predict what the final base level will be." The statement is true, and we shall have to await a future edition for the full value of this feature of the volume.

A chapter on Self Supporting Steel Stacks has been added, with a standard specification for such structures, prepared by the author. A general introduction is followed by data and formulas for the design of stacks, anchor bolts, and foundations, with tables of results for different heights and diameters. Examples and illustrations of half a dozen existing stacks are given, with many useful comments and references.

Another valuable addition to the book is the 29 pp. of tables giving the details and properties of the American Bridge Co.'s Constant Dimensional Steel Columns and Steel Column Footings. These are interesting examples of recent standardization, but may, perhaps, need revision when we reach the desired normal cost situation.

The old tables in Part II have been revised to bring them into agreement with the various changes and additions to their sections that have been made by the mills. Other tables have been rearranged to make them more convenient for the user. A few have become obsolete and could have been omitted. The Index has been rewritten and improved. A further convenience would be a list of the specifications contained in the book, arranged under the names of the societies and other authorities that have issued them.

In conclusion, it is evident that this edition will maintain the reputation of the book as an indispensable aid to the structural engineer, to be procured by those who do not yet own it as well as by those who have worn out their old copies.

Operating Side of Electric Railways

ELECTRIC RAILWAY TRANSPORTATION—By Henry W. Blake, Editor, *Electric Railway Journal*, and Walter Jackson, Fare and Motor-Bus Consultant, Formerly Business Manager and Associate Editor, *Electric Railway Journal*. Second Edition. New York and London: McGraw-Hill Co., Inc. Cloth; 6x9 in.; pp. 449; 121 halftones and drawings. $5.

Few, if any, of the many books on electric railways deal with the transportation methods and practices in such details as this one. Consequently, its field of interest extends beyond that of the engineers interested in the design of electric railway equipment to that of all engineers who have anything to do with electric railways. Such subjects as the relation of service to traffic, acceleration of traffic movement, types of cars as related to traffic, public relations, and the operation of motor buses by electric railways, all dealt with in this book, are of particular interest to engineers who have to do with street traffic in our cities.

The book is in its second edition. So many changes have occurred in the electric railway field since it was first published in 1917 that the entire book has been reset and much new material added. The chapter on bus operation is entirely new.

Short Biographies of Leading Scientists

BEACON LIGHTS OF SCIENCE: A Survey of Human Achievement from the Earliest Recorded Times—By Theo. F. Van Wagenen. New York: Thomas Y. Crowell Co. Cloth; 6x9 in.; pp. 444; 6 halftone plates. $3.

About 225 of the leading scientists, especially pioneers, from ancient times until the present day have been selected by the author for short biographical treatment. The space given to each averages less than two pages, and rarely goes above three or four pages. The arrangement is chronological. For each scientist the dates of birth and death are given and a classification under one of about 35 heads. Often the place of the person in the history of that particular science is stated. This is one of the best features of the book.

No engineer, as such, is included, nor does the word engineer or engineering appear in the index, but two or three of the scientists are recognized as having been engineers, notably Leonardo da Vinci, who is put under General Science. Mechanics is the classification given to Archimedes and James Watt, the only two so classified in the text, although the index gives a cross-reference to Physics.

Sciences having more than five biographies (so classed in text; sometimes many more in index) are: Physics, about 50; Chemistry and Mathematics, about 30 each; Natural History and Astronomy, about 15 each; Electricity, Geology, Biology, Physiology and Botany, from 10 to 6 each. Many of the sciences, or branches of science, have only one representative, as Aeronautics (the Frenchman, Charles), Aviation (Langley), Electro-Chemistry, Embryology, High Explosives (Nobel), Meteorology (Abbe), Pathology Photography, Zoölogy and a few others.

No one is classified under Physics until the Frenchman, Mersenne (1588-1648); under Chemistry until the Irishman, Boyle (1627-1691); under Electricity until the American, Franklin (1706-1790). In contrast "Ancient Times" (which ends here with 250 B.C., from which there is a void until 476 A.D.) includes entries under Astronomy, Anatomy, Botany, Cosmology and Geography, Mathematics, Medicine, Natural Science, Philosophy and Primitive Theories (Thales, the first name in the book).

It would be easy but not worth while to criticize the author for admitting some and omitting other scientists. Protest might be made against the exclusion of all engineers, but to keep any such book as this within reasonable compass a line must be drawn somewhere and drawing it where the author did leaves the field all the more open for some courageous author and publisher to join in the production of a Beacon Lights of Engineering.

A Welcome Revision

PUBLIC WATER SUPPLIES: Requirements, Resources, and the Construction of Works—By F. E. Turneaure, Dr. Eng., Dean of the College of Engineering, and H. L. Russell, Ph.D., Formerly Professor of Bacteriology, both of the University of Wisconsin. Chapter XXVI, on Pumping Machinery, by D. W. Mead, C.E., Professor of Hydraulic and Sanitary Engineering, University of Wisconsin. Chapters VIII, IX, X on Quality of Water Supplies, Revised by C. M. Baker, C.E., State Sanitary Engineer of Wisconsin. Third Edition, Revised. New York: John Wiley & Sons, Inc.; London; Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 766; 300 halftones and line cuts. $6.

For nearly a quarter of a century Turneaure and Russell's Water Supply has been the standard textbook on the subject and has also served as a handy reference work for water-works engineers and superintendents. A revision has been long overdue, and perhaps would have been made before this had it not been for the late war. Considering the wide field covered by the book the revision deserves hearty commendation although it does not make the work so thoroughly representative of water-works practice of today as the first edition was of that of the very beginning of the century. However, the prime essentials of recent changes in theory and practice are included in the new edition.

The Preface states that in the revision "especial attention" was given to "Consumption of Water, Stream Flow, Filtration, Chlorination, the Quality of Water Supplies, Reinforced Concrete in Water-Works Construction, and Pumping Machinery." Of these topics the one that seems to come farthest from adequately reflecting the changes of the past fifteen years is that on pumps, which gives little indication of the way the centrifugal pump, both steam-turbine and electric-driven, has come into wide use, has little to say about any of the internal combustion engines and does not even mention the Diesel oil engine, now of far more significance to water-works men than are some of the other types of pumps and engines to which space is given.

What continues to be one of the most useful features of this book is its extensive references to books and periodicals for supplementary information. These lists do not seem to be as full for the recent as for the earlier years but additions have been made with good judgment—a few to publications of the present decade and at least one to an article printed in 1924.

The foregoing criticisms, it will be seen, relate to minor details and presuppose an ideal difficult to attain in a revision of any comprehensive book so admirably conceived and executed as this one originally was.

British Portland Cement Industry

A HUNDRED YEARS OF PORTLAND CEMENT: 1824-1924—By A. C. Davis, M. Inst. C. E. I., M. I. Mech. E., F. C. S. Issued in 1924 on the occasion of the Centenary of Portland Cement. London: Concrete Publications, Ltd. Cloth or leather; 7 x 10 in.; pp. 282; 40 halftones, 11 line drawings. 21s. in cloth; 25s. leather.

Taking advantage of the hundredth anniversary of the patenting of portland cement by Joseph Aspdin (Dec. 15, 1824), Mr. Davis has written an interesting history of the portland cement industry from the British point of view. He makes it clear that Aspdin contributed little to the portland cement industry but the name. He was a bricklayer who had been experimenting with the lime of his trade and who made some trifling addition to the then existing patent specifications on hydraulic cement. He did, however, christen his product portland cement and the name stuck as the definition of an artificial compound of lime and clay ground and burned to form a hydraulic cement. Aspdin, however, did not note in his patent nor is there any record that he ever discovered the necessity for the burning to incipient fusion, which is the prime characteristic of a portland cement.

This and other interesting facts in the early history of cement are detailed in sufficient explicitness by Mr. Davis, who also traces the development of the cement through the mid-years of the 19th century up to the rotary kiln era of today. A valuable appendix contains a comparison of the current specifications for portland cement in all of the civilized countries and copies of the various early patents on portland and allied cements.

An Aid to Contractors

ACCOUNTING AND BUSINESS METHODS FOR CONTRACTORS—By Charles F. Dingman, M. Am. Soc. C. E., Am. Soc. M. E., N. J. Society of Architects; Author of "Estimating Building Costs," "Plan Reading" and "Quantity Surveying." New York and London: McGraw-Hill Book Co., Inc. Flexible; 4x7 in.; pp. 175; 18 line diagrams. $2.50.

Accounting is about the most puzzling task that confronts the contractor. He knows little of the processes or of their significance and the expert accountant glibly talking technicalities generally increases the contractors' confusion. The contractor solves the problem by passing it on to an employed accountant. This is wholly wise as the contractor's time is better employed in other tasks but it does not meet the requirement that the contractor should know the elements of this part of his business. Generally he desires this knowledge or if he possesses it he wishes his construction managers to have it. To give it is the purpose of this book and it must be granted, we think, that the presentation is remarkably successful. The purpose of the book should not be mistaken. It is not a manual for accountants. It is an elementary discussion of construction cost finding, cost keeping, accounting, purchasing and insurance. The chapters are: Timekeeping, paying off, labor cost finding, material cost keeping, time schedules and progress reports, general bookkeeping on the job, home-office bookkeeping, nominal accounts, customers' accounts, drawing accounts, purchasing, purchasing for specific work, purchasing procedure, sub-contracts, filing methods, miscellaneous records, insurance, banking affairs and contract forms.

Tariff, Tariff Policy and Country's Needs

MAKING THE TARIFF IN THE UNITED STATES—By Thomas Walker Page; With the aid of the Council and Staff of the Institute of Economics. [The Institute of Economics Series.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. 281. $2.50.

Whether or not the tariff is an engineering question, it presents problems that can be correctly solved only by engineering or scientific methods. Moreover, the tariff affects directly or indirectly every engineer and every engineering industry. The book mentioned above may be commended to all citizens as a non-partisan attempt at constructive criticism of the American tariff system, past and present, with recommendations designed to further the assemblage and interpretation of the facts of trade and industry needed to show whether a tariff law is in accord with the tariff policy of the country. Such data, says Dr. H. G. Moulton, director of the Institute of Economics, in his Preface to the book, would "show whether a tariff law is in accord with the needs of the country."

One of the main recommendations of the volume is for "a permanent independent tariff commission,"

composed of a few men of such "ability and experience" as would "inspire confidence in the accuracy and impartiality of their work." The commission should not recommend duties, nor should it attempt "to ascertain the comparative costs of production for use as a measure of duties, because the provision is opposed to the public welfare, cannot be properly administered, and directs the commission's energies from work that is practicable and necessary."

The authors submit a draft of a bill creating a tariff commission of four members, with 12-year terms and salaries of $12,000 a year, to be appointed by the President and confirmed by the Senate, "solely on the grounds of fitness," and with not more than two of the commissioners members of the same political party.

British Road Methods and Materials

ROAD ENGINEERING—By E. L. Fleming, M. Sc., Assoc. M. Inst. C. E. (The Glasgow Text Books, Edited by G. Moncur.) London: Constable & Co., Ltd. Cloth; 6x9 in.; pp. 279; 123 line drawings, insert map of England.

In all that it contains of American practice and experiment, and the aggregate amount is considerable, this book offers nothing that the road builders of the United States have not had except perhaps the expression given of an English engineer's interpretation of their value. Where the author deals more specifically with British methods and materials more interest is aroused. Like all, however, who try to cover all phases of road engineering in a volume of moderate size, the author can only briefly state most of the problems and practices. He, however, grasps and presses home the important lesson that road design and construction can no longer be considered independently of the vehicles which use the road or of the intensity of that use. There are, therefore, chapters on curve super-elevation, traffic censuses, corrugation, and the influence of tires, speed and vehicle design on road surfaces. It is particularly interesting to observe that British road builders are as much concerned over corrugation and shoving as are we in America and so far as the author indicates are as much at sea in their knowledge of the causes and remedies. With the chapters named and those on drainage and on bituminous and tarred roads the interest of the book is about terminated for the American reader. The other chapters deal with each of the several types of road, with structures and with road-construction equipment.

PUBLICATIONS RECEIVED

GASOLINE TAXES are levied in 36 states and the District of Columbia, according to a statistical and textual summary entitled The Administration of Gasoline Taxes in the United States, by James W. Martin, Emory University (October Supplement to *National Municipal Review*, 261 Broadway, New York City).

THE METHOD OF PRECISE LEVELING across bodies of water too wide for ordinary sighting and not spanned by any structure across which a line of levels may be carried is described in a paper written by Ajudhia Nath Khosla of the Punjab Irrigation District. This booklet explains an adaptation of a widely practiced method. Mr. Khosla has invented a special movable target with a slow-motion screw for fine adjustment as its principal virtue. Additional accuracy and speed are insured through the use, by the rodman, of a telescope through which to observe signals given by the levelman. Mr. Khosla has included in his exhaustive paper part of a bulletin on precise leveling compiled by Hugh C. Mitchell, mathematician of the U. S. Coast and Geodetic Survey, and abstracted in *Engineering News-Record*, Aug. 23, 1923. Mr. Khosla is assistant executive engineer of the Ferozepore district, Punjab, India (P. O. adress, Suleimanki Headworks).

A 45-YEAR INDEX to the Transactions of the American Society of Mechanical Engineers (1880-1923) will be a great convenience to many. Besides alphabetical entries by subjects and authors there is an index to memorial notices. (29 W. 39th St., New York City; $3.)

A PROGRESS REPORT on Studies of Impact, Skunk River Bridge, near Ames, Iowa, by Prof. Almon H. Fuller, representing joint work by the U. S. Bureau of Public Roads, the Iowa State Highway Commission and the Iowa Engineering Experiment Station (Ames, Iowa) has been published by the latter.

TAPERED STRUTS: A Theoretical and Experimental Investigation, by James E. Boyd, Professor of Mathematics, Ohio State University (Columbus) has been published as Bulletin 25 of the Engineering Experiment Station of the institution named.

MANCHURIA, LAND OF OPPORTUNITIES, first issued in 1922, has been revised. Those interested in business opportunities in that country may obtain the book (98 pp., halftones and folding map) from the New York Office of the South Manchuria Railway Co., 111 Broadway.

PROGRESS ON THE REGIONAL PLAN of New York and Its Environs to May of this year is summarized in a pamphlet issued by the committee in charge which has also issued a report on the Traffic Problems Conference held by the committee on May 20 (25c. each; 130 East 22nd St., New York City).

PARKS AND PLAYGROUNDS as elements in the city plan, by Henry V. Hubbard, Professor of Landscape Architecture, Harvard University (Cambridge, Mass., a 25-p. pamphlet) is a paper first read before the American City Planning Conference, then revised for the International Town Planning Conference held at Amsterdam in 1924.

FIFTY PAGES of the October *Journal* of the Boston Society of Civil Engineers (Tremont Temple; 50c. a copy) are filled with a paper on Flood Flows of New England Rivers, by C. H. Pierce.

A MONTHY JOURNAL called the *Factory Mutual Record* is now being published "in the interest of fire prevention" by the Inspection Department of the Factory Mutual Fire Insurance Companies (184 High St., Boston, Mass.).

TELEGRAPH AND TELEPHONE STATISTICS for 1922 are given in two small pamphlets issued by the Bureau of the Census (Washington, D. C.).

BULLETIN No. 4 of the School of Engineering Research, University of Toronto (Ontario) is devoted to the second part of a paper on Gunite as a Protection for Steel Structures, by Peter Gillespie, Professor of Civil Engineering and P. J. Culliton, Research Assistant.

A TILTING FRAMEWORK, adjustable to different slopes, was used in A Comparative Test of the Flow of Water in 8-Inch Concrete and Vitrified Clay Sewer Pipe (jointed up to make lengths of 98 ft.) conducted at the Engineering Experiment Station of the University of Washington. (Seattle; 50c.) The paper on the tests is by Elgin B. Wilcox, professor of civil engineering. The velocity-depth curves plotted from the test data "show a consistently lower velocity in the concrete than in the vitrified clay pipes, under identical conditions. They also show that there is a decided tendency for the differences in velocities to become relatively less as the slope of the pipes increases. The quantity-depth curves support the same conclusions."

GALVESTON, HOUSTON AND TEXAS CITY, Texas, are covered by the sixth volume of the Port Series, prepared by the Board of Engineers for Rivers and Harbors in co-operation with the Shipping Board. Like its predecessors this volume gives full information with regard to port and harbor conditions, port customs and regulations, services, fuel and supplies, and facilities available at each port. It also gives statistics of foreign and domestic commerce, a discussion of railroad import and export rates applying to gulf ports in general and tables showing comparative positions of these ports with those on North and South Atlantic

Seaboard. The earlier volumes of the series deal with the ports of Portland, Me., of Boston, Mobile, Pensacola, Philadelphia, Camden, Chester, and Wilmington, and New Orleans. (75c. from Superintendent of Documents, Washington, D. C.)

ELEVEN STATES have adopted and 18 other states have proposed more or less comprehensive schemes for consolidation of the administrative branches of their government, according to a revised edition of Administrative Consolidation in State Governments, by A. E. Buck. (New York: National Municipal League, 261 Broadway; 25c. a copy or $15 per 100.)

DAILY RIVER STAGES at River Gage Station on the Principal Rivers of the United States, for 1923, a U. S. Weather Bureau publication (Washington, D. C.) gives besides river stages a record of the floods of 1923 and miscellaneous data on the river stations.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1924-25; Containing Reference and Design Data Useful in the Planning and Construction of Modern Heating and Ventilating Installations—Prepared from the Society's Transactions—Investigations of Its Research Laboratory—and the Practice of Its Members; Together with A Catalog and Reference Data Section Containing Essential and Reliable Facts Concerning Modern Equipment, and The Roll of Membership of the Society. Vol. 3. New York: Published Annually by American Society of Heating and Ventilating Engineers. Cloth; 6x9 in.: pp.: text, 232, catalog, 224, roll of membership, 52. $3.

AMERICA'S INTEREST IN WORLD PEACE—By Irving Fisher, Professor of Economics in Yale University. New York and London: Funk & Wagnalls Co. Paper; 5x7 in.; pp. 123. 60c.; rates on quantities.

A. S. T. M. TENTATIVE STANDARDS: 1924—Philadelphia: American Society for Testing Materials: Cloth or Paper; 6x9 in.; pp. 763; halftones, diagrams, charts, tables, index; at end, Tentative Revisions of A. S. T. M. Standards. $8, cloth; $7, paper.

DIE ARBEITSFESTIGKEIT DER EISENBETONBALKEN—Von Wilhelm Thiel, Ingenieur. Berlin: Julius Springer. Paper; 7x10 in.; pp. 53; 4 line cuts. 55 marks (gold) in Germany.

DER AUFBAU DES MÖRTELS IM BETON: Beitrag zur Vorausbestimmung der Festigkeitseigenschaften des Betons auf der Haustalle. Untersuchungen über die Zweckmassige Zusammensetzung des Zementmörtels im Beton namentlich über den Einfluss der Korngrobe des Sandes auf die Druckfestigkeit und das Raumgewicht des Zementmörtels. Veresuchsergebnisse und Erfahrungen aus der Materialprüfungsanstalt der Technischen Hochschule, Stuttgart—Von Otto Graf, Berlin: Julius Springer. Paper; 6x9 in.; pp. 63; 41 line cuts.

BLOCKADE AND SEA POWER: The Blockade, 1914-1919, and Its Significance for a World State—By Maurice Parmelee, Ph.D., Author of "The Science of Human Behavior," etc. New York: Thomas Y. Crowell Co. Cloth; 6x9 in.; pp. 449. $3.
The author states in his Preface that "this book is a protest against nationalism, navalism, and militarism, and a slight essay toward the attainment of the supreme goal of the political evolution of mankind—the World State."

DRAFTING-ROOM MATHEMATICS: Problems of the Drafting-Room Simply and Clearly Explained for the Draftsman and the Architect—By DeWitt C. Pond, Author of "Concrete Construction for Architects." New York: Charles Scribner's Sons. Cloth; 5x8 in.; pp. 153; 40 line cuts. $2.50.
Simple explanations of mathematical problems encountered in ordinary drafting-room routine of architects and engineers. Structural design as well as simpler matters are included. Of particular interest are three chapters on "setbacks," made necessary in New York City by the passage in 1916 of the zoning ordinance. The law and its application are graphically explained so that engineers unacquainted with such structural modifications may know just what restrictions zoning legislation imposes.

DIE EISENKONSTRUKTIONEN DER INGENIEUR-HOCHBAUTEN: Ein Lehrbuch zum Gebrauche an technischen Hochschulen und in der Praxis—Von Dr.-Ing. e.h. Max Foerster, Geheimer Hofrat, ordentlicher Professor für Bauingenieur-Wissenschaften an der Technischen Hochschule, Dresden. Fifth, completely revised, Edition. Leipzig: Wilhelm Engelmann. Cloth; 8x11 in.; pp. 1320; 1400 structural drawings and halftones; tables. Cloth, 45 marks (gold), paper, 42 marks (gold), in Germany.

ELECTRIC RAILWAY HANDBOOK: A Reference Book of Practice Data, Formulas and Tables for the Use of Operators, Engineers and Students—By Albert S. Richey, E.E., Consulting Engineer, Professor of Electric Railway Engineering, Worcester Polytechnic Institute, Fellow of the American Institute of Electrical Engineers, (Second Edition.) New York and London: McGraw-Hill Book Co., Inc. Flexible; 4x7 in.; pp. 798; many line drawings and data tables.

EYE HAZARDS IN INDUSTRIAL OCCUPATIONS—By Louis Resnick and Lewis H. Carris. A handbook for safety engineers, safety inspectors, safety committeemen, industrial physicians and nurses, etc., for governmental officials, trade association officials, etc. New York: National Committee for the Prevention of Blindness, Inc. Paper or fabrikoid; 6x9 in.; pp. 247; 59 halftones. Paper, linen back, $1.50; fabrikoid, $2.50.

FACTORY FLOOR SURFACES—By A. B. MacMillan, Chief Engineer, Aberthaw Co. (Aberthaw Text No. 2.) Boston: Aberthaw Co. Boards; 6x9 in.; pp. 34; line sketches. $1.
An admirable little treatise on the various methods of building and finishing floors for industrial plants. Will be furnished free to engineers, builders, industrial owners and others to whom it would be of value.

LANDWIRTSCHAFTLICHER WASSERBAU, FISCHEREILICHER WASSERBAU, DÜNENBAU UND SEEDEICHE—Bearbeitet und herausgegeben von Paul Gerhardt, Wirklichem Geheimen Oberbaurat in Berlin, Ordentlichem Mitgliede der Akademie des Bauwesens. [Fünfte, vermehrte und teilweise neubearbeitete Auflage; Siebenter Band; III. Teil des Handbuches der Ingenieurwissenschaften, Der Wasserbau.] Leipzig: Wilhelm Engelmann. Half leather; 8x10 in.; pp. 655; 670 line cuts and halftones, and full index. Bound, 34 gold marks, paper, 31 gold marks, in Germany.

LEGAL FOUNDATIONS OF CAPITALISM—By John R. Commons, Professor of Economics in the University of Wisconsin. New York: The Macmillan Co. Cloth; 6x9 in.; pp. 394. $3.

MATHEMATICAL TABLES: Reprinted from Searles and Ives' Field Engineering, with Additions—Compiled and Arranged by Howard Chapin Ives, Professor of Railroad Engineering in the Worcester Polytechnic Institute. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. Flexible; 4x7 in.; pp. 130. $1.25.
Compiled primarily for the use of students and engineers who make frequent use of mathematical tables and need them in a convenient form, this book is made up of tables of logarithms, natural functions, squares, cubes and roots, inches and minutes in decimals of feet and degrees, fifth and five halves powers and fifth roots, diameters, and areas of circles in eighths and tenths, and trigonometrical functions. An explanation of the tables is included. Most of the tables are from Searles and Ives' Field Engineering and part from Merriman's Civil Engineers' Handbook.

THE MEXICAN YEAR BOOK 1922-24—Edited by Robert Glass Cleland, Ph.D. Los Angeles: Times-Mirror Press. Cloth; 6x9 in.; pp. 582; maps, charts, tabulations.

THE MODERN THEORY AND PRACTICE OF PUMPING: A Treatise on the Application of the Reynolds-Stanton Law of Viscous Flow to Modern Pumping Problems and the Flow of Liquids through Pipes—By Norman Swindin, M. I. Chem. E., A. M. I. Mech. E. New York: D. Van Nostrand Co. Cloth; 7x10 in.; pp. 364; 281 halftones and line cuts. $10.

OUR DARDANELLES: The Projected St. Lawrence Route—By John B. Baldwin. The author: 1623 Pensacola St., Honolulu, Hawaii. Paper; 6x9 in.; pp. 83.
An argument against the St. Lawrence waterway, based almost entirely on the disadvantageous military signficance of such a waterway. A fallacious comparison is made with the problem of the Dardanelles, forgetting that the Dardanelles hinterland has no other outlet to the sea, forgetting also that in case of war, which might possibly close the St. Lawrence to American shipping, only a small part of the transcontinental freight would be affected and that if world conditions were such that it were unsafe for an American ship to go down the St. Lawrence, certainly the whole ocean trade would be likewise threatened. The book suggests as an alternative a further development of the New York State Barge Canal mainly by repealing the law which forbids railroads from running boats thereon.

PRACTICAL BRICKLAYING: A Handbook of Construction and Manual for the Journeyman—By Howard L. Briggs, B.S., M.A., Director of Vocational Education, Cleveland Public Schools. Revised and Enlarged by William Carver, Architect, The Common Brick Manufacturers Association of America. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. 223; 172 halftones and line cuts. $1.75.
To the engineer this volume is a most interesting one because of its illustrations. Those showing various bonds for brickwork and illustrating laying operations are particularly deserving of attention. The construction engineer and contractor's field superintendent can hardly err in putting this book on his working library shelves. As the product of half a score collaborators, including architects, contracting builders, practical bricklayers and bricklayers' apprentice teachers, this book inspires belief in its accuracy.

STRUCTURAL ENGINEERING: STRENGTH OF MATERIALS—By George Fillmore Swain, LL.D., Gordon McKay Professor of Civil Engineering in Harvard University; formerly Chairman of the Boston Transit Commission and Consulting Engineer of the Massachusetts Railroad Commission; Past President Am.Soc.C.E.; M.Inst.C.E., Am.Soc.M.E., Eng. Inst. of Canada, Am.Soc.T.M., Am. Ry. Eng. Assoc., etc. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 569; 469 line drawings and halftones. $5.

THE THEORY AND APPLICATION OF COLLOIDAL BEHAVIOR: Contributed by the Foremost Authorities in Each Division of the Subject—Robert Herman Bogue (Editor), Director of Research for the Portland Cement Association; Formerly Associate Professor of Chemistry at Lafayette College. Volume I: THE THEORY OF COLLOIDAL BEHAVIOR. Volume II: THE APPLICATION OF COLLOIDAL BEHAVIOR. [International Chemical Series.] Cloth; 6x8 in.; Vol. I, pp. 464; Vol. II, pp. 406; halftones and line cuts. $8 for the two volumes.
A highly technical exposition of a subject of growing importance, by 34 carefully chosen specialists, written with a view of the application of colloidal chemistry in industry. Heterogeneous equilibria, surface kinetics, adsorption and catalysis and structure, and mineral, vegetable and animal products are the main topics. In the concluding chapter, John Arthur Wilson takes up colloid chemistry in relation to the development of the activated-sludge process of sewage treatment at Milwaukee.

THOMAS ALVA EDISON: An Intimate Record—By Francis Arthur Jones. [Revised Edition.] New York: Thomas Y. Crowell Co. Cloth; 6x8 in.; pp. 399; illustrated. $5.
The popular story of Edison's life and achievements written some years ago (see *Engineering News*, March 12, 1908, for more detailed characterization), has been revised and extended to cover the later activities of the "Wizard of Menlo Park."

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Underestimating and Vision

Sir—Your editorial in the issue of Nov. 6, 1924, "Why Do Engineers Underestimate?" was worthy of more than passing notice.

That an engineer shall be broad enough to see the proposition put up to him in its all around phases is talking in fundamentals. You are stirring up the necessity for broad ening studies to accompany slide rules and algebraic symbols; for the engineer's ability to think all round the question, and furthermore to talk all round it, as well as write about it.

When we discuss the *responsibility* of the engineer in regard to correct estimating, it is not so much the responsibility as it is the ability to see the necessity of informing his principal what expenditure confronts him, unless, indeed only some technical portion of the matter has been the issue.

Generally, the principal is looking for light on what he is going to spend, and, quite generally, he does not know what he wants in sufficient detail to give more than an idea to his engineer. Shall engineers, therefore be only tools, or shall they be mind readers? Shall we continue to teach facts and physical research, or shall we include psychology and expression in the engineering student's curriculum?

New York City, Nov. 15, 1924.

T. Howard Barnes, Consulting Engineer.

Gravel Road Corrugations

Sir—In *Engineering News-Record*, Oct. 30, 1924, p. 722, there appears a letter from George Hogarth, chief engineer, Department of Public Highways, Ontario, relative to gravel road corrugations. Mr. Hogarth asks that other highway engineers state their views on this subject.

I am familiar with Dr. Ladd's theory, which is a reasonable explanation for the direct cause of some corrugations but does not explain why the corrugations form in some places and not in others, as contended in the editorial in *Engineering News-Record*, Oct. 16, 1924, p. 614.

If we analyze this situation we can soon discover the answer. In order to form in corrugations parts of the surface material must be capable of being compacted into a hard mass, at least temporarily. A soft dirt road becomes rutted instead of corrugated because a wheel *cuts through* instead of *pushing ahead* the material through which it is passing. As soon as a material of different density is introduced we begin to get a condition conducive to forming of corrugations; if a wheel load is passed over a dirt surface of varying density the wheel cuts in more deeply in some places than others and we have the beginning of corrugations. We find that corrugations can be formed in dirt roads, gravel roads, stone roads; in fact in all kinds of surfaces where there is not a perfect binding material, to prevent displacement. Probably we can safely state that the principal reason why corrugations occur is that all parts of a road surface do not offer equal resistance to moving wheels. We can also state that corrugations can be formed in road surfaces which are composed of materials not sufficiently bonded to prevent displacement but which have enough plasticity to permit their taking new shapes. And corrugations can be formed in road surfaces composed of materials of varying composition and densities, which will permit some parts to be displaced more rapidly than others.

The principal reasons for corrugations in gravel roads are: Improper grading of materials; poor quality materials; poor foundation; surface too thin; poor bonding, either due to binder or rolling; improper maintenance. Given some of these conditions the traffic will make corrugations; correct the wrong conditions and traffic will simply consolidate the surface. Of course a gravel road cannot be expected to stand up under excessively heavy traffic or without a reasonable amount of maintenance.

Pittsburgh, Pa., Nov. 14, 1924.

F. R. Quackenbush, Civil Engineer.

Calculating Equal Payments

Sir—The problem of how long it will take to pay off a debt when the payments are uniform and include the interest due has been presented to me several times. Working it out one step at a time is a long process, especially if the payments are made monthly, and I derived the following general equation. It probably exists some place else though I could find it in no text and it may be of interest to engineers who are consulted occasionally on mathematical questions.

Let P equal the principal, a the equal payments, r the interest rate expressed decimally (thus 6 per cent = 0.06), and N the number of payments.

Then:

$$N = \frac{\log a - \log (a - rP)}{\log (1 + r)}$$

If $a = yP$ or y = ratio of payment to total debt, then:

$$N = \frac{\log y - \log (y - r)}{\log (1 + r)}$$

Let P' = balance due after n payments have been made, then:

$$P' = P (1 + r)^n - a \frac{(1 + r)^n - 1}{r}$$

Pacific Grove, Calif., Oct. 20, 1924.

Reeve Conover, Del Monte Properties Co.

Manila Storm Sewers Designed for 2-In. Rainfall per Hour

Sir—In an editorial note on "Storm Water Sewer Limits" in your issue of Sept. 11, 1924, p. 409, you state: "It is an engineering truism, that storm sewers large enough to carry the heaviest downpours would bankrupt a city, etc," and in closing you say, "How many and what cities keep records that enable their engineers to establish a policy in this matter or, if one has been established, to check its soundness?" "And, what is or should be the policy?"

Upon my arrival in Manila in 1903 I was assigned to the position of engineer-in-charge of storm-water drains, which included design, construction and maintenance of them. The few existing drains which served for both sanitary sewers and storm drains were built by the Spanish engineers many years ago, long before drains were designed and built with any scientific basis, and apparently were intended to be large enough to carry off a considerable amount of rainfall. The result was that they constantly silted up, and had to be cleaned very often, and that much sediment had to be removed every year, as the city is very flat, and the velocities in the drains were insufficient to carry away the silt.

Having had a considerable amount of experience and responsibility in the design of the Havana, Cuba, sewer and drainage system, where the Kuichling method of drainage design was used on a considerable scale, the same methods, modified to suit local conditions, were adopted. Fortunately, the Jesuit fathers under Reverend Father Dr. José Algue, who are in charge of the Meteorological Bureau, had a complete record of the rainfall in Manila since 1865, or for almost 40 years. I found that there were 16 rainfal's in the 40 years in excess of 2 in. per hour, and the duration of these was for less than one hour. On the other hand, 2-in. rainfalls for more than an hour period occurred quite often. I therefore advised that the drains be designed for a rainfall of 2 in. per hour, and that if it rained for a short period at a greater rate the streets would be temporarily flooded, also stating that to build drains to carry off the heaviest rainfalls would bankrupt the city. I may add that the recommendations were adopted, and all our drains are built for a 2-in. rainfall only.

A. Gideon, Manager, Metropolitan Water District.

Manila, P. I.
Oct. 15, 1924.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

The Emergency Having Been Met on the irrigation projects below Lake Tahoe, pumping from the lake has stopped. Some four months will be required before the lake is restored to its normal level.

The President Is About to Fill the vacancy which has existed on the International Joint Commission since the death of Senator Townsend, Aug. 3. Among those being considered for the vacancy is Senator L. H. Ball of Delaware, whose term in the Senate will expire in March. Senator Ball is a physician by profession.

A Proposal Has Been Submitted by Major Richard Burgess of El Paso for the surplus and return water of the Elephant Butte reservoir. The water is desired for use on the continuing irrigation district below El Paso. The application is of particular importance, since it raises the whole question of Rio Grande water rights.

The Chief Engineer of the Terminal Railroad Association at St. Louis, Mo., is H. J. Pfeifer. In speaking of the retirement of Edward A. Kolbe, *Engineering News-Record*, Nov. 13, p. 809, statement was erronously made that he was until recently chief engineer of the association, whereas that position has been held by Mr. Pfeifer for some time.

The Last Serious Obstacle to the completion of the Toronto viaduct agreement within the time fixed by the Dominion government was cleared away a few days ago, when the principals of the contracting parties met for a final conference. As a result of the decisions reached at that conference actual construction work probably will commence in April. Eighteen months later it is expected trains will steam into the new Union station, and by 1928, for the first time in over 50 years, Toronto will have unobstructed access to its waterfront.

The City of Portland, Oregon, has plans for an extensive improvement through the heart of the city along the Willamette River. A board of consulting engineers, consisting of M. M. O'Shaughnessey, city engineer of San Francisco; J. C. Stevens, consulting engineer of Portland; and Charles W. Staniford, consulting engineer of New York City, has been appointed to consider this project. The board met in Portland, Nov. 17. The plans include one mile of retaining wall along the river to take care of the high freshet conditions which reach a height of 32 ft., improved railroad and terminal stations, warehouses, etc.

Vehicular Tunnel Named for Clifford M. Holland

As a tribute to its chief engineer, Clifford M. Holland, whose death at the age of 41 years was noted in these columns recently, the Hudson vehicular tunnel has been named the Holland Tunnel. The name was officially adopted in a resolution passed by a joint meeting of the New York and New Jersey tunnel commissions held in the Woolworth Building, New York City, location of the New York commission, Nov. 12. A biography and appreciation of Mr. Holland's services to engineering on his last and largest project were contained in *Engineering News-Record*, Oct. 30, p. 723.

Illinois Central R.R. Lets Contracts for New Line

With the letting of the construction contracts for the new Edgewood-Fulton line, 175 miles, the Illinois Central R.R. has taken the final step towards the provision of a new route between Chicago and the South, diverting much of the through traffic from the congested line over the old Ohio River bridge at Cairo to the newer double-track bridge at Metropolis. Six of the eight sections of the work are now under contract and the others are to be let shortly. Construction work has been started.

This important line has been planned under the direction of F. L. Thompson, chief engineer of the Illinois Central R. R.

New Jersey Sanitary Association To Meet In Atlantic City

Among the papers on the program of the annual meeting of the New Jersey Sanitary Association, to be held at Atlantic City, Dec. 5 and 6, are "Where Will the Water Supply Come From Twenty Years From Today?" by H. T. Critchlow, hydraulic engineer, Department of Conservation and Development, with discussion opened by Morris Sherred, consulting engineer, North Jersey District Water Supply Commission; "Sanitation for the Camper and Hiker," by James E. Brooks consulting engineer, Glen Ridge; and "Zoning in the State and Its Bearing on Public Health," by Edward L. Katzenbach, attorney-general.

The subject of the president's address, by T. F. Appleby, of Asbury Park, N. J., will be National Oil Polution Legislation.

Los Angeles Aqueduct Seized and Waste Gates Opened

Waste gates on the Los Angeles aqueduct near Lone Pine were opened on Nov. 16 and the flow diverted from the aqueduct by a party of ranchers of Inyo County acting in the struggle of the ranchers to bring about a settlement according to their own ideas of mooted irrigation water-right questions. The sheriff of Inyo County appealed at once to the governor for state troops, stating that about a hundred armed citizens were resisting attempts to close the waste gates and asking for troops to avert bloodshed. Up to the evening of Nov. 17 the governor had not considered it advisable to send troops. A temporary injunction against the raiders was issued by the Superior Court and served on the raiders on Nov. 17, but without effect. A number of the raiders were also served with notices of damage suits to be brought by the city. The waste gates are located near the upper end of the aqueduct, at a point above the storage reservoirs.

On May 17 a portion of the aqueduct near Lone Pine was dynamited by the ranchers and since then a Los Angeles attorney representing the city at Bishop, on the line of the aqueduct, was taken out of town by a band of men and told never to return. (See *Engineering News-Record*, June 5, p. 991, for an account of the dynamiting and a statement of the complaints of the ranchers).

Samuel Rea Honored by Philadelphia Engineers Club

Approximately 300 members and guests of the Engineers Club of Philadelphia met Nov. 12 at a luncheon in honor of Samuel Rea who will soon retire as president of the Pennsylvania R.R. The occasion for the luncheon was the presentation from the club to Mr. Rea of a certificate of honorary-life membership. Guests at the luncheon included a number of Philadelphia's most prominent men as well as engineers and railway executives from all parts of the country. Either presidents or high officials of ten railroads attended the luncheon.

Chief among the speakers was Charles M. Schwab who has been a close friend of Mr. Rea for 52 years. Other speakers included William C. L. Eglin, president of the Franklin Institute; Samuel M. Vauclain of the Baldwin Locomotive Works; Dr. Josiah H. Penniman, president of the University of Pennsylvania; Howard Elliott, chairman of the Board of Directors of the Northern Pacific R.R.; and Conrad N. Lauer, president of the Engineers Club of Philadelphia.

Wheel-Guards Proposed in Springfield Bridge Report

Commissioner Investigates Structure Following Damage To Railing By Skidding Taxicab

The Hampden County Memorial Bridge across the Connecticut River at Springfield, Mass., is safe, according to a report by William F. Williams, state commissioner of public works, who investigated complaints of defects on the order of Gov. Cox. The complaints followed an accident in the early morning of Sept. 9, when a taxicab crossing the bridge, and having its brakes applied vigorously because of an accident to another vehicle, skidded and ran up over the curb and across the sidewalk and knocked about 15 ft. of the railing into the river. Reports then spread that the bridge was endangered by seepage of water, and also that blast action of gases in the smoke from locomotives passing under the eastern end of the structure indicated that the concrete was of inferior quality.

Structure Found Safe

Commissioner Williams finds no evidence of stress or weakness in the superstructure of the bridge that would justify any suspicion of its safety. Concerning the railing he says:

"The appearance of the railing is attractive and substantial, but it is not sufficiently anchored to the superstructure to withstand the shock of a motor vehicle or possibly the pressure of a crowd of people. The ability of this type of railing to resist overturning depends chiefly upon its weight, although longer and larger dowels would have added to its stability, but it is doubtful if it can be made safe against the direct impact of a heavy motor vehicle. This statement might also be made with respect to most if not all of the older type of bridge railings. In fact, it is doubtful if it is practicable or desirable to place entire dependence upon the railing if the bridge is wide enough to permit a head-on collision by a motor vehicle." He suggests, however, that heavy wheel guards be built on top of or in front of the curb and that the anchorage of the railing be strengthened. Concerning the other complaints he says:

"My attention was called to seepage of water and blast action by locomotive gases on the under side of the concrete viaduct over the railroad tracks in Springfield, but I found no serious deterioration of the structure from the causes referred to. The seepage was confined mostly to the under side of the sidewalk near the gutter line. It may be due to the holes that have been drilled through the concrete slab to provide drainage for water collecting in the space occupied by the gas mains, or it may come from water entering at an expansion joint following the slab and gradually seeping through it. The authorities in charge of the bridge should ascertain the exact cause of the seepage and apply the proper remedy.

"The same suggestion applies to the blast action of locomotive gases, which is entirely external and the effect is easily inspected."

California May Increase Gas Tax to Three Cents

A bill to increase the California state gasoline tax from two cents to three cents will be introduced when the state legislature convenes. The bill will be introduced by Senator Arthur Breed, of Oakland, who declares the one-cent tax would raise $6,000,000 to $7,000,000 more revenue. He also says a proposal may also be made to increase the license fee by $2 to enable the state highway commission to have $15,000,000 a year for highway work. The State Board of Control, the senator reports, has ordered 1,500,000 sets of license plates for 1925. This contemplates a large increase over the present number of automobiles.

Chicago Diversion Case Postponed

Argument before the Supreme Court of the United States of the Chicago diversion case, which was to have taken place last week, has been postponed until Dec. 10, a Washington dispatch advises. This action was taken at the request of the Solicitor-General of the United States.

New Bids on American Falls Dam to Be Taken Dec. 20

Washington Correspondence

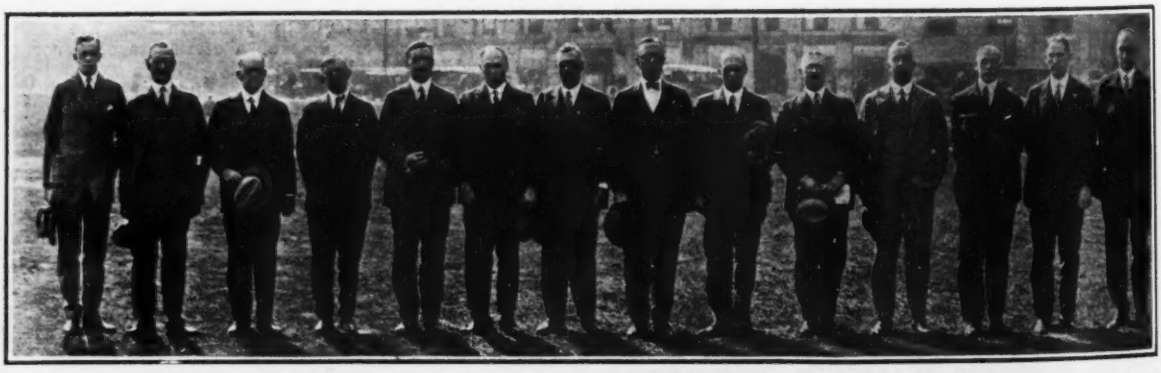
New bids for the American Falls dam, at American Falls, Idaho, have been called for by the Commissioner of Reclamation. This followed the formal rejection of the two bids opened on Oct. 20. The new bids are to be opened Dec. 20 under changed specifications which provide for the building of the foundation only of the river section of the dam.

The revised specifications provide for 48,000 cu.yd. of excavation and the placing of 41,000 cu.yd. of concrete. Approximately 600,000 lb. of reinforcing steel and 237,000 lb. of structural steel are called for in the revised specifications. The gates will weigh 1,700,000 lb.

The original specifications provided for bids on a high dam and on a lower structure. The Utah Construction Co. at Salt Lake City was the low bidder for the low dam, while Atkinson & Atkinson of Portland were the low bidders for the high dam. After the bids were open it became apparent that the foundation for the low dam should be enlarged so as to permit of the ultimate heightening of the dam. Atkinson & Atkinson objected to the granting of the contract under the changed specifications to the low bidder on the low dam as originally planned. This led to the rejection of both bids and the readvertisement of the project under the new specifications. The change in plan will not delay the completion of the project, it is declared, and storage will be available for 1926.

Colors of 27th Engineers Placed in Engineers Building

The regimental colors of the 27th Engineers were placed in the custody of the United Engineering Society by the state of New York on Nov. 14 in order that they may be displayed in the society's building in New York City. The regiment was composed largely of mining engineers and many of its officers were drawn from the American Institute of Mining and Metallurgical Engineers, which organization is a member of the United Engineering Society.



ENGINEERING BOARD OF REVIEW OF SANITARY DISTRICT OF CHICAGO'S

Left to right: Paul H. Norcross, T. Chalkley Hatton, James H. Fuertes, Morris Knowles, Silas M. Woodward, Dean Anson Marston, Clarence W. Hubbell, Ezra B. Whitman, George H. Fenkell, Prof. John H. Gregory, Asa E. Phillips, Dr. F. H. Newell

New England to Hold Transport Conference Dec. 11-12

A New England motor transport conference to discuss the highway transportation problems of New England will be held at Boston Dec. 11 and 12, under the guidance of the National Automobile Chamber of Commerce, and with the co-operation of many New England organizations representing motor vehicle users.

Railroad men and trolley officials will be among the speakers, and special sessions of the conference will be devoted entirely to discussion of how electric railways are using the motor bus, and how railroads are solving, with the motor truck, the problem of handling local less-than-carload freight.

The rapid progress which has been made in New England and elsewhere in building up a network of intercity motor coach operation will be discussed. Among the speakers will be some of the pioneers in this development.

Other speakers will explain what the commercial use of New England's great new highway system means in dollars and cents, and of how the automobile is helping to reclaim New England's deserted farms. The federal government's research program into the economics of road use will also be presented.

One of the most important topics will be a discussion of how to promote safety and reduce highway congestion.

Besides members of automobile organizations, railroad men and electric railway representatives, state highway officials, mayors, city planning experts, shippers and others will be invited to the New England Motor Transport Conference.

Engineers Examining Board Meets in Washington

Round-table discussions relating to methods of procedure used by the different boards, means of enforcing registration laws, methods for expeditiously carrying on examinations, and the adoption of a uniform application blank for reciprocal registration were chief accomplishments of the Council of State Boards of Engineering Examiners at the fifth annual convention, held in Washington, D. C., Nov. 10 and 11. The principal address was given at a banquet on Nov. 10 by Dean G. M. Butler, of the University of Arizona, and president of the council. His subject was "What is the Matter With Engineering?"

On Monday at noon the delegates of the council were received by President Coolidge. At noon on Tuesday the delegates were the guests at lunch of the American Engineering Council, represented by A. C. Oliphant, assistant secretary, and in the afternoon were taken on a sightseeing trip in charge of A. B. McDaniel, secretary of the American Association of Engineers' Washington office.

The following were elected officers for the coming year: President, L. M. Martin, chairman of the Iowa state board; vice-president, Paul Doty, chairman of the Minnesota board; secretary-treasurer, T. Keith Legaré, secretary of the South Carolina board, re-elected.

The following were in attendance. G. M. Butler, president, of Arizona; George E. Taylor, vice-president, of West Virginia; T. Keith Legaré, secretary-treasurer, of South Carolina; John J. Cox, of Michigan; C. S. Hammett, of Florida; Lewis M. Martin, of Iowa; G. A. Covell, of Oregon; Herbert Foltz, Daniel B. Luten and Harry M. Bell, of Indiana; Paul Doty, of Minnesota; P. H. Daggett, Harry Tucker and N. S. Mullican, of North Carolina; Richard L. Humphrey, of Pennsylvania, and John Berg, of South Dakota.

Pier Fire Endangers Erie Station

Fire which destroyed two Erie R.R. piers, fourteen barges and a lighter on the Jersey City water front at New York on Nov. 16, for a time threatened the adjoining passenger station and ferry slips. The two piers which were destroyed were filled with freight which will also be a total loss, thus bringing the damage up to $2,000,000. J. J. Mantell, vice-president of the Erie, stated that reconstruction of the piers would be begun at once.

Council-Manager Charter Drafted for Kansas City, Mo.

A tentative draft of a council-manager form of city charter, with proportional representation, a non-partisan ballot, the initiative, referendum and recall, and modern budget and accounting methods, has been made for Kansas City by its charter commission authorized some months ago and pledged to that general form of charter. The draft has been submitted for public discussion before its completion and its submission to the voters.

The council would consist of nine members of whom the mayor and four others would be elected at large while the remaining four would be elected each to serve one of four districts outlined in the draft. There would be eight city departments, each headed by a director appointed by the city manager: Finance, public works, law, parks, public welfare, fire, personnel (in place of existing civil service commission) and utilities. When the state laws permit there would be a city police department (now controlled by the state government). Among the 15 members of the charter commission is L. R. Ash, consulting engineer.

Copies of the proposed charter may be obtained from the charter commission, Orear-Leslie Building.

Water Power Development Started at St. Narcisse, Que.

The Shawinigan Water & Power Co. has started another power development at St. Narcisse on the Batiscan River, Que. The company's subsidiary, the North Shore Power Co., has a power development at this point, with an output of 1,200 hp., which will be abandoned upon the completion of the redevelopment of the site, to obtain 10,000 hp. The new development includes the construction of a dam just about Grande Chute and the construction of a tunnel 13 ft. in diameter and 3,500 ft. long, which will bypass the existing plant to a new power house site further down the river at Chute des Cheminées.

The work is expected to be completed in May, 1926, and to cost about $1,500,000.

LAKE LOWERING CONTROVERSY AND REMEDIAL PROGRAM

W. W. DeBerard, Arthur E. Morgan, Wynkoop Kiersted, C. E. Grunsky, John B. Hawley, Col. C. S. Riché, Dean E. E. Haskell, John R. Freeman, J. F. Hasskarl, Francis Lee Stuart, Robert E. Horton, Col. J. L. Ludlow, George W. Fuller, Richard R. Lyman, Harrison P. Eddy, G. G. Earl.

Water Purification in Ohio

At the fourth annual State Conference on Water Purification in Ohio, held at Cincinnati, Nov. 11 to 14, one of the principal subjects of discussion was the pollution of river water by trade acids from gas and coke manufacturing plants. According to a paper by W. H. Dittoe, chief engineer of the Ohio State Department of Public Health, this condition is becoming more serious, while no purifying treatment will remove the offensive taste. Chlorination, to improve the quality, is said to make the taste still worse. A survey of the present situation is being made by the Department of Health and it is expected that a report will be made in 1925.

One day was devoted to visits to the Cincinnati filtration plant and pumping stations and the experimental filter plant and laboratories of the U. S. Public Health Service.

At the annual dinner, O. F. Schoepfle, superintendent of filtration at Sandusky, related experiences in handling the water supply when the filtration plant was practically destroyed by a tornado in June. The meeting was presided over by Clarence Bahlman, superintendent of filtration at Cincinnati.

Rivers and Harbors Congress Speakers Announced

Definite acceptances have been received by the National Rivers and Harbors Congress of invitations to speak at the twentieth annual convention, which is to be held in Washington, D. C., Dec. 10 and 11, from these speakers whose subjects are:

George F. Sproule, director of the Department of Wharves, Docks and Ferries, "Philadelphia"; John F. Miller, member of congress, "Seattle"; Maj.-Gen. Harry Taylor, Chief of Engineers, "Recent Progress on River and Harbor Work"; Brig.-Gen. T. Q. Ashburn, chairman of the Executive Board of the U. S. Inland Waterways Corp. on "The Inland Waterways Corporation of the United States"; Frederic H. Fay, Boston, "The Influence of the Welland Canal Improvements upon Freight Movements on the Great Lakes"; Edwin H. Duff, Washington, D. C., "Effect of the Seaman's Act upon Great Lakes Transportation"; Charles E. Ashburner, city manager of Stockton, Calif., "Inland Ports"; and W. T. Donnelly, New York City, "River and Harbor Transportation with Increased Dispatch and Lower Cost."

Free ports will be discussed affirmatively by Frank S. Davis, manager of the Maritime Association, Boston Chamber of Commerce, and negatively by Wilbur F. Wakeman, New York City, treasurer and general secretary of the American Protective Tariff League.

The view held on port differentials by North Atlantic ports will be presented by Julius Henry Cohen, general counsel of the Port of New York Authority, and that by South Atlantic ports by Thomas J. Burke, traffic commissioner of the Charleston Chamber of Commerce.

Status of Ohio River Dams

Of the fifty dams and locks to form the complete series between Pittsburgh, Pa., and Cairo, Ill., for the maintenance of slackwater navigation on the Ohio River, thirty-eight are completed and ten are under construction, leaving only two more to be undertaken, according to a report presented at the annual meeting of the Ohio Valley Improvement Association, held at Cincinnati, Ohio, Nov. 11 and 12. One of the aims of this association is to secure the completion of the entire series of locks and dams by 1929. Major Daley, U. S. district engineer at Pittsburgh, spoke of the Monongahela River improvement and its value to the industries of Pittsburgh. W. C. Devereaux, U. S. Weather Bureau, Cincinnati, referred to a high-level wave which is to be passed down the river as far as Louisville to facilitate the passage of large coal fleets.

Oscar F. Barrett and W. C. Calkins, both of Cincinnati, were elected president and secretary of the association.

Two Southern Lines Plan Double-Tracking 160 Miles

Speaking at St. Augustine, Fla., the general manager of the Florida East Coast Ry. stated recently that 60 miles of additional second track had been authorized by the executive committee of his company. Part of the new double tracking will be just to the south of St. Augustine, part both north and south of West Palm Beach, and part north of Miami.

In South Carolina it has been announced that the Atlantic Coast Line will begin the construction of double tracks between Drayton Hall and Yemassee and between Florence and Lanes, a total distance of about 100 miles. Double-tracking between Yemassee and Savannah has been in progress during the past season.

The Atlantic Coast Line has also authorized the construction of the remaining 11 miles of the Miami Belt Line.

Civil Service Examinations

NEW YORK STATE

For the following civil service examinations apply to the New York State Civil Service Commission, Albany, N. Y., before Dec. 3, 1924:

Assistant Civil Engineer, Long Island State Park Commission—One immediate appointment, salary $3,000, position being open to non-residents as well as residents of New York State.

Architectural Draftsmen—Junior, in state department of architecture, salary $1,800 to $2,100; and draftsman, salary $1,500. Open to non-residents.

Junior Assistant Civil Engineer—Grade 1, vacancies in the State Highway Bureau and other departments, salary $1,620 to $1,860. Open to non-residents.

Examinations will be conducted Dec. 13.

Random Lines

Playing No Favorites

Last year it was reported that one of the war-time concrete ships had been bought by a "hotel keeper" who was going to anchor it a judicious distance off the Florida coast and rent it to "fishing parties." Now the coast guard has commandeered three more of these ships to be used off the Jersey Coast as supply bases for the motor-boat fleet that is harrying Rum Row there. The concrete ship exhibits a delightful impartiality in trying to get itself utilized.

* * *

Roads As a By-Product

Lamb's Chinaman who had to burn down a house every time he wanted roast pig is approached in Aspdin's famous original patent on portland cement, now just 100 years old. Aspdin wanted powdered limestone as the main ingredient in his product and he proposed to get it by taking "a specific quantity of limestone, such as that generally used for making or repairing roads," and, he adds "I take it from the roads after it is reduced to a puddle, or powder." What a wonderful highway system Lehigh and Northampton Counties in Pennsylvania would have if this idea had been carried through until today.

* * *

The Household Engineer

By Elldee

The engineer who builds a dam or loosens up a traffic jam or figures out a means and ways of making better corset stays, deserves and gets the credit due—as sure as measles or the flu. His fellow men arise as one, and cheer and maybe shoot a gun; for he has done a stunt worth while—and added something to his pile.

But what of her who leaves the hay when Big Ben sounds the break of day, and stumbles into icy clothes and down the dingy stairway goes to rout out coffee pot and pan that she may prime some misfit man and get him started down the trail, to land his meagre meed of kale?

What of the Household Engineer!—who builds the meals and skims the beer, and draws the water for the wash and figures how to pickle squash so that when northern zephyrs screech it tastes like candied Spanish peach! What of the meek and lowly soul who as the laggard seasons roll, day in, day out, with mop and broom, goes valiantly from room to room and by the magic of her touch makes of the dank and dingy hutch a cheery nest in which to pass the few short hours man's home, alas!?

Who engineers the old household? Who fights the moth and rust and mold, and struggles with the pots and pans, the knives and forks and jars and cans? Who skimps and saves to pay the bills for coal and gas and Barko Pills?—who, tho she may be weak and faint sticks to the job without complaint—and oft without a word of cheer?—Who, but the Household Engineer!?

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, San Francisco, Calif., Nov. 17-20, 1924.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION, New York City; Annual Meeting, New York City, Dec. 2, 1924.

ADVISORY BOARD ON HIGHWAY RESEARCH, Washington, D. C.; Annual Meeting, Washington, Dec. 4-5, 1924.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Ill., Jan. 5-9, 1925.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 12-14, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 21-23.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Montreal, Jan. 27-29, 1925.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 24-27, 1925.

The Central States Section of the American Water Works Association will hold its annual meeting in Wheeling, W. Va., Dec. 5 and 6. A special feature will be an inspection trip to Wheeling's 20-m.g. electric pumping station and filtration plant.

The Affiliated Technical Societies of Boston on Nov. 19 at its first meeting of the season was addressed by E. J. Mehren, vice-president of McGraw-Hill Co., Inc., and former editor of *Engineering News-Record*, on "The European Economic Outlook."

The Associated General Contractors of America will hold its sixth annual convention in Washington, D. C., Jan. 12-14. A program of the meeting will be published in these columns in a later issue.

Personal Notes

BARRY DIBBLE, electrical engineer, U. S. Bureau of Reclamation, and former project manager in charge of the Minidoka Project and the American Falls, Idaho, development, has resigned to enter private practice in southern California. Mr. Dibble was graduated from the electrical engineering department of the University of Minnesota in 1903. His early professional work included positions as designer and construction engineer for the Cincinnati & Columbus Traction Co., in charge of operation of the Shawinigan Water and Power Co. station at Shawinigan Falls, Que., and assistant superintendent of the St. Paul Gas Light Co. He became connected with the U. S. Bureau of Reclamation in 1909. Though his most recent work has been supervising electrical and mechanical work of the Bureau, to which position he was appointed a year ago, perhaps his greatest work has been in connection with the American Falls project. Mr. Dibble there worked out a number of the most difficult problems, physical and human, on which the success of the project depended; the prospective construction of the American Falls dam—bids were received Oct. 20 and new bids on revised specifications are to be taken Dec. 20—will be largely based on his work.

HENRY E. RIGGS, dean of the school of engineering of the University of Michigan, was chosen to make a valuation of the street railways of Kansas City, Mo., his valuation to be independent of the valuation made by the bondholders of the street railways' property. Dean Riggs graduated from the University of Kansas in 1886; for some time he was chief engineer of the Toledo, Ann Arbor & Northern Michigan Ry., and in his railway engineering career has built approximately 500 miles of electric and steam railway. He has been consulting engineer on steam and electric railways and other public utilities.

GEORGE A. HENDERSON, consulting engineer with the Ordnance Department, U. S. Army, has resigned to go into private practice in New York City, in an office at 51 W. 66th St., and will specialize in safety methods as applied to construction, industrial plants and celluloid, chemical and explosives manufacture.

DR. HOWARD TURNER BARNES, who recently joined the staff of McGill University at Montreal, as senior professor of physics, is best known to the engineering profession as a research expert on ice formation and its influence on water-power development and on navigation. Dr. Barnes is a native of Massachusetts but his family moved to Montreal and he graduated from McGill University in 1893. He has done research work on ice conditions in the St. Lawrence River, on icebergs and other ice conditions, is the author of treatises on the subject and the inventor of ice research testing instruments. Owing to heavy war work on research problems in connection with submarines on behalf of the British Admiralty, his health broke down and he but recently took up teaching again.

F. M. FAUDE has resigned as hydraulic engineer in the engineering division of the California State Railroad Commission, effective Dec. 1. M. R. MACKALL has been appointed his successor. Mr. Faude has been connected with the commission for seven years and held the post of hydraulic engineer for the past year and a half. He was formerly connected with the Northern Pacific R.R., United States Reclamation Service and engaged in private practice of engineering to which he plans to return. Mr. MacKall has been connected with the California State Railroad Commission since April, 1920, as assistant engineer in the hydraulic division. He saw service in France during the World War.

G. C. FITZGERALD, formerly associated with the firm of Leeds & Barnard, consulting engineers, Los Angeles, has accepted an appointment as chief engineer of the East Side Organization, which is planning public improvements such as streets, highways, sewer systems, etc., in the east side industrial area of Los Angeles.

MARTIN T. HOOPER, consulting engineer, specializing in mechanical and electrical layouts for buildings, power plants, etc., has opened offices at 634 I. W. Hellman Building, Los Angeles. Mr. Hooper was, until recently, field engineer for the U. S. Public Health Service of Washington, D. C., specializing in design and tests of heating and ventilating equipment for public buildings and schools.

JOEL D. JUSTIN, hydraulic engineer of The Power Corporation of New York, Watertown, N. Y., has been engaged as consulting engineer by the Japanese government to go to Formosa and make an investigation and report on the feasibility of a project involving a large hydraulic-fill dam. The proposed dam will be about 165 ft. high and will contain about 5,000,000 cu.yd. of material. Mr. Justin will leave San Francisco Dec. 5 on the Korea and expects to return to this country next March.

R. H. MCMASTER of Montreal, vice-president and director of the Steel Co. of Canada, has been elected a director of the Canadian Pacific Ry. Co.

WINFIELD PARSONS, resident engineer, Birmingham, Ala., is the first city engineer of Birmingham, the office having been recently created by the city council. The motive for the establishment of the office was the fact that the city administration has planned extensive street improvements and considered it good business to employ a capable engineer for full-time service.

Obituary

GABRIEL HENRY, consulting engineer of the Department of Roads of the Province of Quebec, died Oct. 9, aged 62 years. Mr. Henry was born at Ardennes, France, was educated at the École Centrale at Paris, and then went to Canada to try his fortune. He had been active in construction and improvement of the highways of the province for many years.

PATRICK J. SLATTERY, Lafayette, Ind., who had been engaged in road building and street paving, died recently in a hospital in Decatur, Ill., aged 74 years. Mr. Slattery was formerly a partner, at Crawfordsville, Ind., of James Harding in paving work throughout the state.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Making Cables for Delaware River Bridge

For Philadelphia-Camden Structure 25,100 Miles of Wire Will Form Two 30-In. Cables Each With Tensile Strength of 57,500 Tons

By Walter Voigtlander, M.E.
Engineer, American Cable Co.

FOR the two huge 30-in. steel cables which will carry the Philadelphia-Camden bridge over the Delaware River, the Page Steel & Wire Co., at its plant in Monessen, Pa., is manufacturing for the American Cable Co. 25,100 miles of wire to meet the most rigid specifications ever placed on cab'e wire and to form the strongest cables ever made. Each of the cables is 3,550 ft. long, weighs 3,500 tons—practically a ton per linear foot—and is formed of 61 strands of 306 wires each, or a total of 37,332 individual wires (0.195 in diameter) for the two cables. While designed to resist a pull of 36,700,000 lb., each cable, according to the results of tests already made, will have an actual tensile strength of 115,000,000 lb.

Methods of Manufacture—The steel is acid open hearth of rigid chemical specifications. Each ingot, billet, bundle of rod and bundle of wire carries the individual heat number from the time it leaves the steel mill until the finished wire is delivered. The following steps are taken to insure the high quality and uniformity the Bridge Commission demands:

Billets are heated to a carefully determined temperature and passed on roll tables to the rod mill. Here they are reduced to round wire rods, a careful inspection after each operation resulting in the rejection of any rods that show laps, seams, fins or slivers.

Then comes a special heat-treating process which, with the subsequent cold-passing, is largely responsible for the full development of the wire's tensile strength. The wire is drawn through a series of separate dies at carefully regulated speeds. Each pass must result in a given reduction to insure the proper amount of cold work. The size and uniformity of the wire after each cold drawing are carefully inspected. The structure and tensile strength depend almost wholly on the care with which the special heat treatment and cold drawing are carried out. A high degree of uniformity is achieved. After the final cold drawing, the bright wire varies in gage less than 0.003 in. It is so hard it will cut ordinary glass, and yet it can be bent cold around a rod 1½ times its own diameter without sign of fracture.

Inspection and Tests

Galvanizing—The regulations covering galvanizing are also rigid. The zinc coat is 99.75 per cent pure, which will be recognized as an achievement by those familiar with this process. Naturally, the temperature of the zinc bath and the speed of the wire through it must be watched closely to prevent too great an effect on the heat-treated wire which might result in excessive loss of tensile strength. The gage of the galvanized wire is no more than 0.005 greater than that of the bright wire; it must stand a bend about a 2-in. mandrel without visible cracking and four 1-min. immersions in standard copper sulphate solution.

Tensile Strength—Then come the final inspection and the tensile tests. The end of each bundle of finished wire, continuous for 3,000 ft. without splices, is carefully tested to the breaking point for tensile strength, elongation and yield point. The Page Steel & Wire Co. has been able to better the specifications which call for 215,000 lb. per square inch and elongation of 4 per cent in 10 in., and a yield point of 144,000 lb. per square inch. The average tensile strength of the wire, according to the tests, is 223,000 lb. per square inch, the strongest wire yet used in bridge construction.

The bundles of wire are spliced on reels of 80,000 ft. each, or 8,000 lb. of wire. The splices are made with sleeves with right and left hand threads and the wire ends are mitered which locks them against unthreading.

Though each cable is designed to resist a pull of only 36,700,000 lb., tests of strands of this wire show a tensile efficiency of more than 95 per cent of the individual wires which would give each main cable a tensile strength of something more than 115,000,000 lb., by far the strongest cables ever made. Contrary to the general belief that the processes of wire drawing make the exterior metal stronger than the core, tests show practically the same unit tensile strength for this wire when it is turned down to half the specified diameter.

Spinning — Spinning these great cables presents some unusual difficulties. The wire is carried across the river in the usual fashion on traveling sheaves or trolleys fastened to an endless cable. Two cables and four trolleys are used, each cable carrying two trolleys. When a strand is begun the end of the wire from a reel is fastened to an anchor shoe, and the loop or bight is passed over the trolley wheel. At the same time a similar operation is taking place on the other shore. The cable, operated by a motor, is then set in motion, and carries either loop to the opposite shore where it is passed over the anchor shoe. Thus each trolley adds two wires to its strand at each crossing.

On smaller bridges only one endless cable is usually used, the two trolleys alternating on either main cable, the running cable crossing from one side of the bridge to the other with its trolley on either shore. But this plan would have "spun out" the spinning of the cables where 37,332 wires must be placed, so two running cables are used, one on each main cable.

Great care must be taken to see that no curls or kinks get into the wire as the spinning proceeds. Should kinking occur, the kink is cut out and the wire sleeve-spliced as mentioned above, an undesirable happening, for it holds up the work of the trolleys. When any strand has 306 wires in cross-section, made up of a continuous spliced length of 1,086,000 ft. of wire, the spinning stops on that particular strand, and another is begun while workmen seize the strand with temporary seizing of wire. In the meantime, the trolleys have begun work on other strands, each pair of trolleys building four strands at once.

Squeezing Cable—One of the greatest difficulties comes when the strands are completed, and they must be squeezed into the completed cable. In the case of smaller cables this has presented no great difficulty, hand squeezers usually being sufficient to hold the strands while the cables are being wound. A large hydraulic press is necessary in this case. Using a 5-ft. length of cable, which is an exact duplication of one of the finished main cables, tests made in the American Cable Co.'s Newark plant determined the amount of pressure necessary to reduce the strands from their normal aggregate diameter of 35½ in. to the 30 in. which was the final size obtained.

Form Clay Products Institute

With representatives present from the American Face Brick Association, Clay Products Association, Common Brick Manufacturers Association, Hollow Building Tile Association, National Paving Brick Manufacturers Association and the National Terra Cotta Society, action was taken at a meeting in Chicago last month to create the Clay Products Institute. The new organization, those interested in it point out, will mean much to the heavy clay products industries not only in bringing them closer together on problems of joint interest but in affording means for research.

Frank Butterworth, general manager of the Western Brick Co., Danville, Ill., was elected president of the Clay Products Institute. The other officers are W. P. Whitney, president, Springfield Paving Brick Co., Springfield, Ill., vice-president; and J. S. Sleeper, secretary, Hollow Building Tile Association, secretary. The secretaryship will rotate from year to year among the secretaries of the member associations. The institute will hold annual meetings during the fourth week in April in Washington, D. C.

Fig. 1—Delaware River Bridge Showing Cable Spinning Operations in Progress—Running Cables Supported Over Main Cable Saddles

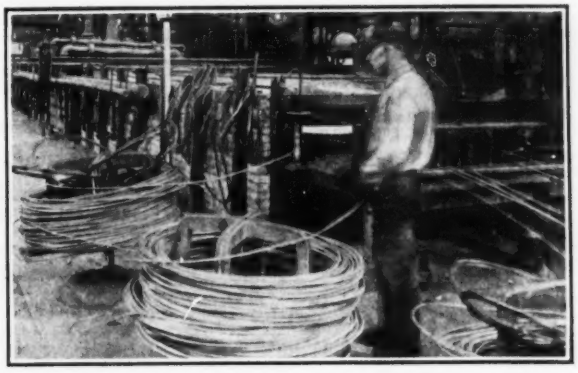


Fig. 3—Final Heat Treatment of Rod Before Cold Drawing Begins—Finished Wire Involves a Score of Hot and Cold Workings

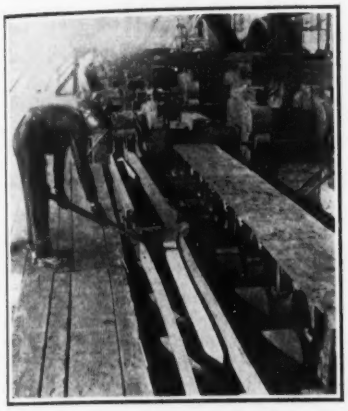


Fig. 2—Heated Billets on Their Way Through Rod Mill

Delaware River Bridge Construction Progress and Details of the Manufacturing Processes for Producing its 30-in. Diameter Galvanized Steel Wire Cables

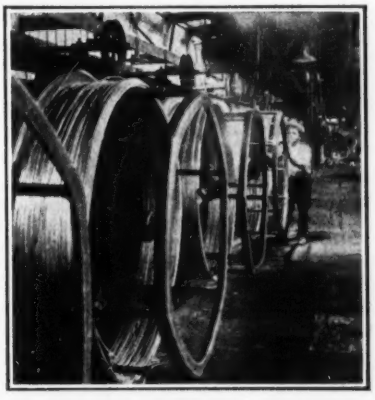


Fig. 5—After Galvanizing—Wire from Zinc Bath Air Cooled Before Winding on Reels

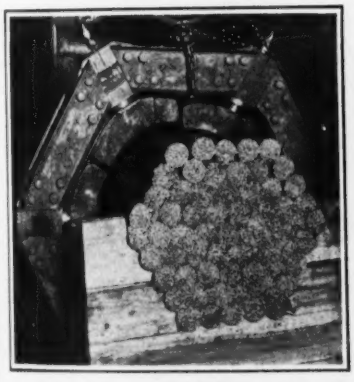


Fig. 6—Before Squeezing Strands Have Diameter of 35⅛ In.

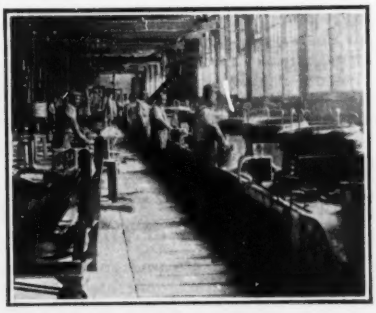


Fig. 4—Rotating Blocks which Pull Wire Through Dies

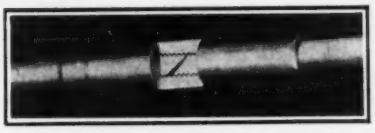


Fig. 8—Spliced Wire

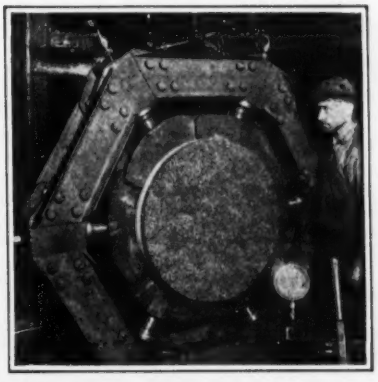


Fig. 7—After Squeezing—Diameter Reduced to 30 In.

The press is made up of six hydraulic pressure cylinders with shoes having concave faces, arcs of a circle 30 in. in diameter. The squeeze necessary to form the cable was determined at 30 tons, of which 15 tons reduced the diameter 5 in., and the remaining 15 tons were necessary to make the final ½-in. reduction.

The suspender ropes, also furnished by the American Cable Co., will number 596. They are made with a 7 x 7 wire rope center, surrounded by 6 strands of 37 wires each and have a nominal diameter of 2¼ in. The suspender ropes will weigh 400 net tons, which, with the cables, will give the suspension elements a total weight of 7,400 tons.

The dead weight of the main span is estimated at 26,000 lb. per foot, and the live-load capacity at 12,000 lb. per foot.

The bridge is being built by the Delaware River Bridge Joint Commission under the direction of a board of engineers of which Ralph Modjeski is chief engineer and George S. Webster and Laurence A. Ball are members.

Business Notes

W. N. DURBIN, former president, and R. I. Van Winkle, former secretary of the Anderson Foundry & Machine Co., associated with J. E. Hennings and Linfield Meyers, Anderson bankers, have incorporated the National Engineering & Equipment Co. of Anderson, Ind. The company will specialize in power plant equipment and kindred lines with special attention to power plant design of modernized and economical char-

acter in the central, western and southern states. Mr. Durbin was associated in an official capacity with the Anderson Foundry & Machine Co. for 35 years, manufacturing and marketing saw mill, brick and clay machinery, tin plate machinery and Anderson oil engines.

I. G. MELROSE, formerly district sales manager for Bear Tractors, Inc., New York, announces the opening of an office at 921 Adolphus Hotel, Dallas, Texas, for the wholesale and retail distribution of contracting and industrial equipment and heavy machinery.

FOOTE BROS. GEAR & MACHINE CO., Chicago, has recently opened the following sales offices: 100 Greenwich St., New York, in charge of J. R. Shays, Jr.; Jackson Bldg., Buffalo, in charge of R. F. Mosedale, and 1306 Keenan Bldg., Pittsburgh, in charge of Wm. G. Kerr.

UNIVERSAL CRANE CO., Elyria, Ohio, has appointed A. E. Ensell, 1628 Market St., Philadelphia, Pa., to care for its customers in that city and neighboring territory.

SUPERIOR SUPPLY CO., Chicago, distributor of construction, railroad and industrial equipment, has recently added to its sales force, R. D. Allrich, formerly western sales manager of the Blaw-Knox Co.

SANDUSKY CEMENT CO., Cleveland, announces the appointment of A. T. McCormack as general sales manager succeeding Clinton B. Rogers, recently resigned.

DEAN PUMP & MFG. CO., Indianapolis, Ind., has purchased at receiver's sale the Hill Pump Works, of Anderson, Ind. The Hill concern was a former subsidiary of the Midwest Engine Co., which has gone out of existence.

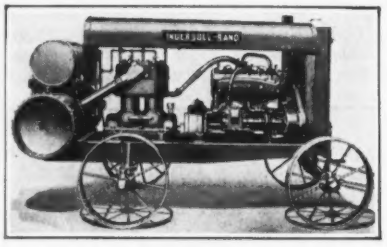
Road Show Space Over-subscribed

In spite of the fact that space for heavy exhibits at the Good Roads Show, to be held in the Coliseum, Chicago, Jan. 5-9, has been increased 25 per cent over the area available last year, results of the official drawing made at Chicago, Nov. 10, indicate an over-subscription on the part of prospective exhibitors of 100 per cent. This means, according to officials of the Road Show, that in order to accommodate all applicants, there must be a general trimming down of the exhibit areas desired by individual manufacturers. In view of present conditions, the decision has been made to narrow the aisles in the Coliseum somewhat to provide more room for setting up machinery exhibits. In a letter which is being sent to manufacturers of road-building equipment and material, C. R. Ege, on behalf of the Highway Industries Exhibitors Association, and J. H. Cranford, representing the executive committee of the American Road Builders' Association, are urging exhibitors to co-operate with the committee on arrangements for the Road Show in adapting their displays to the new restrictions in area caused by the unprecedented number of manufacturers desiring to show their products at the Coliseum in January.

Equipment and Materials

Small Portable Air Compressor

A recent addition to the line of portable air compressors made by the Ingersoll-Rand Co., New York, is the 4½ x 4-in. duplex unit with a piston displacement of 60 cu.ft. per minute, driven by a four-cylinder gasoline engine. The types of mounting that can be furnished include steel wheels and



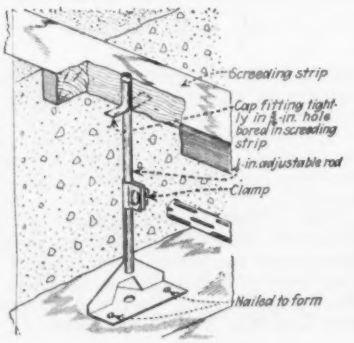
axles, wooden artillery wheels with solid rubber tires and steel axles, a Ford truck chassis or skids for mounting in a car or truck. Electric motor drive may be substituted for the gasoline engine.

The compressor has sufficient capacity to operate any one of the following tools: Jackhammer, paving breaker, trench digger or riveting hammer. It will operate two of the following tools: Backfill tampers, calking or chipping hammers.

Among the features of the new unit are a circulating water cooling system for engine and compressor with sectionalized radiator, fan and pump; compressor regulator and engine control for reducing load during unloaded periods; one-piece cast-steel frame; and sheet steel roof and removable side doors.

Adjustable Target Aids Leveling and Screeding of Concrete

To insure accurate and speedy leveling or screeding of concrete slabs in building and other forms of construction the M. & M. Wire Clamp Co., Minneapolis, offers an adjustable rod target consisting of a one-piece metal base with short vertical arm carrying a screw clamping device which grips a short length of ¼-in. rod or a 60-penny nail. The rod slides up and down in a groove in the vertical arm and its top



may be set and clamped at an elevation equivalent to the thickness of the slab. Prior to concreting the target is fixed rigidly in place by driving a couple of nails through holes in the base plate and into the wooden forms forming the bottom of the concrete slab.

The targets may be used in two ways: First, simply as guides or markers to indicate the correct surface elevation of the poured concrete; in this method the targets are generally placed on about 5-ft. centers and a short length of wire or a stamped metal flag is attached vertically to the top of the rod to indicate the position of the target in case the poured concrete should cover the marker. In the second method the targets are employed as supports for wooden screed strips; ⅜-in. holes are bored in the wood strips on 4-ft. centers and into them are inserted metal caps with ¼-in. horizontal wings or lugs. Into these capped holes the top of the target rod fits snugly, thus providing a vertical support for holding the screeding strip in its proper place. The accompanying sketch indicates the use of the target equipment.

Publications from the Construction Industry

Gasoline Locomotives.—VULCAN IRON WORKS, Wilkes-Barre, Pa., have issued a new 20-p. bulletin, devoted to worm gear drive gasoline locomotives. In addition to a description there are illustrations showing various parts of the locomotive. A 4-p. leaflet is enclosed giving the rated hauling capacities of all the popular sizes from 3 to 25 tons.

Resurfacing Worn Macadam—TEXAS CO., New York, is distributing a 20-p. illustrated booklet of vest-pocket size offering suggestions on the resurfacing of worn macadam and gravel roads, with specific directions for the use of Texaco sheet asphalt, asphaltic concrete, or asphalt macadam.

Portable Concrete Mixers — THE ARCHER IRON WORKS, Chicago, has a new 16-p. pamphlet on its portable concrete mixers of 5 and 7 cu. ft. capacity, with drum and engine mounted on a two-wheel platform or on the frame of a motor-truck. Special advantage is claimed for the end-discharge arrangement, but the motor-truck machines may have either end or side discharge. Loading may be done directly by wheelbarrows, or a skip and discharge chute can be attached.

Light Weight Safes — GLOBE-WERNICKE, Cincinnati, has issued a 24-p. illustrated pamphlet on its light weight structural steel safes for office records, blueprints and tracings. The largest of the units, which are built in a wide variety of sizes, has inside dimensions of 56⅝ in. in height, 45½ in. in width, and 28¾ in. in depth. The maximum floor load imposed by these safes is 207 lb. per square foot. They are built with a heavy angular steel frame sheathed with a 14-gage steel body. A feature of the construction is the thermo-cel insulation between the outer and inner plates.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Steel, Lumber and Cement Demand Increasing

Cement Shipments Reach New High Level—Common Labor Easily Obtainable—Scarcity in Few Skilled Trades

In considering current demand as applied to the basic factors used in computing *Engineering News-Record's* Construction Cost Index Number, it develops that the pressure is greater upon the materials than upon construction labor.

Taking steel first, the accompanying table shows the tonnages on books of the U. S. Steel Corporation as of the last day in each month, this year and last.

UNFILLED ORDERS ON BOOKS OF THE U. S. STEEL CORPORATION'S SUBSIDIARIES ON THE LAST DAY OF EACH MONTH

	1924 Tons	1923 Tons
January	4,798,429	6,910,776
February	4,912,901	7,283,989
March	4,782,807	7,403,332
April	4,208,447	7,288,509
May	3,628,089	6,981,351
June	3,262,505	6,386,261
July	3,187,072	5,910,763
August	3,289,577	5,414,663
September	3,473,780	5,035,750
October	3,525,270	4,672,825
November	.....	4,368,584
December	.....	4,445,339

Although the quantities were heavier last year, running up into six and seven million tons monthly with the largest unfilled total this year at 4,912,901 tons, the trend in demand has been steadily upward since July, 1924. Last year the opposite condition prevailed; from March to November, 1923, there was a steady falling off in steel requirements.

Lumber orders (new business) for the week of Nov. 1 totaled 225,152,603 ft., according to the National Lumber Manufacturers Association. This represents returns from 367 of the chief commercial soft-wood lumber mills of the country.

The total referred to shows a gain in demand of 4 per cent over the preceding week and 11 per cent over the corresponding period last year.

CEMENT PRODUCTION AND SHIPMENTS—THIS YEAR AND LAST

	Production 1923 Thousand bbl.	Production 1924 Thousand bbl.	Shipments 1923 Thousand bbl.	Shipments 1924 Thousand bbl.
First Quarter	26,030	27,746	24,044	20,138
Second Quarter	36,651	39,041	40,518	42,358
July	12,620	14,029	13,712	16,614
August	12,967	15,128	14,971	16,855
September	13,109	14,519	13,698	16,827
October	13,350	14,820	14,285	17,081

Latest reports of the Geological Survey show October cement shipments from mills throughout the country to have exceeded the total for that month in any previous year on record. This increased demand has resulted in a national cement reserve (at mills) of 6,143,000 bbl., Oct. 31, 1924, against 18,189,000 bbl. on March 31, 1924.

While the present reserve stock is 33 per cent higher than it was a year ago it represents the smallest quantity available on the last day of any month since Oct. 31, 1923.

CEMENT STOCKS AT MILLS IN U. S.

	1923 Barrels	1924 Barrels
January	11,477,000	14,155,000
February	13,596,000	16,815,000
March	13,045,000	18,189,000
April	11,463,000	17,159,000
May	10,144,000	16,403,000
June	9,168,000	14,903,000
July	8,081,000	12,319,000
August	6,080,000	10,666,000
September	5,533,000	8,404,000
October	4,612,000	6,143,000

(*Continued on p. 854*)

Public Bond Sales in October

The amount of state and municipal bonds sold during October, according to *The Commercial and Financial Chronicle*, very nearly reached the September total and is a little in excess of the sales for October, 1923.

The aggregate of awards for last month is $85,121,159 while the September total is $85,613,982. These sums may be compared with $84,988,615 for October, 1923.

In the accompanying table, three sales were at par, two below par and the remainder brought a premium. The rates range from 4 to 6 per cent.

REPRESENTATIVE PUBLIC BOND SALES, OCTOBER, 1924

State	Purpose	Amount	Rate per Cent	Sold For	Basis	Dated	Maturity	Purchased By
Michigan	Roads	$17,000	4½	100.15	....	Oct. 7	2 to 6 yrs.	Detroit Trust Co.
		20,000		100.2	....	Oct. 7	2 to 3 yrs.	
County								
Allegheny, Pa.	Road	1,800,000	..	102.26	4.055	Sept. 1	1925—54	Union Trust Co. and others
	bridge	3,658,000						
Beaufort, N. C.	Road and bridge	500,000	5	100	5	.....	.....	Kalman, Gates, White & Co.
Clackamas, Ore.	Road improvement	95,000	5	102.08	4 61	Sept. 1	1928—35	A. B. Leach & Co., Inc.
Carroll, Ind.	Highway improvement	13,640	4½	100.6	4.385	Aug. 5	1925—34	Wm. J. Guckien
Cass, Mich.	Road	18,000	5½	103	5 34	Nov. 1	1 to 10 yrs.	Detroit Trust Co.
Carroll, Md.	Road	39,000	4½	101.15	4.295	July 1	1927—33	John P. Baer & Co.
Dodge, Wis.	Highway	500,000	5	106.5736	4.27	April 1	1931—44	The Second Ward Securities Co.
Dade, Fla.	Highway	330,000	5	102.01	4 84	Oct. 1	1925—54	Herbert C. Heller & Co. and others
Delaware, Ind.	Drainage	13,219	6	100.20	5.905	July 23	1925—28	Fletcher-American Bank of Indianapolis
Floyd, Ind.	Highway	6,640	5	102.60	4 46	Oct. 4	1925—34	J. F. Wild & Co.
Greene, Ind.	Road	14,400	5	103.02	4.37	Oct. 15	1925—34	First National Bank of Linton
Garfield, Okla.	Road and bridge	100,000	5	103.99	4.50	July 1	1934	Enid National Bank
Township								
Hanover, Pa.	Schools	195,000	4½	.....	....	.....	.....	Frank Mullen & Co.
Newburg, O.	Road improvement	3,209	6	102.45	5.46	Oct. 1	1925—34	David Robison & Co. of Toledo
Jefferson, Pa.	Road	120,000	4½	100.38	4.46	June 1	1925—44	W. A. Harriman & Co.
Municipal								
Atlanta, Ga.	Improvement	175,000	4½	101.38	4.22	Oct. 1	1927—33	Roosevelt & Son
Akron, O.	Improvement	707,200	5½	104.819	4.415	Oct. 1	1926—33	W. L. Slayton & Co. and Ryan, Bowman & Co.
Anniston, Ala.	Street improvement	100,000	5½	100	5½	Oct. 1	1944	Ward, Sterne & Co.
Arkansas City, Kan.	Paving	94,307	5	102.80	4.86	Aug. 1	10 yrs.	Prudential Trust Co.
Arnold, Pa.	Street improvement	50,000	4½	102.82	4.37	Aug. 1	.....	Lewis & Snyder
Beloit, Wis.	Sewer	50,000	4½	102.36	4.24	Sept. 15	1925—44	A. C. Allyn & Co.
Berwick, La.	Water and light	45,000	6	.....	....	Aug. 1	1925—44	Marine Bank & Trust Co.
Columbus, O.	Street	100,000	5	106.39	4.33	Nov. 1	1925—34	Prendergast & Co., Herbert C. Heller & Co.
	Building	380,000	5	106.39	4.33	Dec. 1	1925—49	
	Sewer	263,000	5	106.39	4.33	Mar. 1	1926—50	
Canton, O.	Improvement	118,930	5½	104.40	4.87	Sept. 1	1926—34	Seasongood & Mayer
Chicago, Ill.	Improvement	4,375,000	4	99.061	4.11	Jan. 1	1933—43	A. B. Leach & Co. and others
Danvers, Mass.	Water	100,000	4	101.03	3.95	Oct. 1	1925—54	Old Colony Trust Co.
Depew, N. Y.	Sewer and street	23,500	4½	100.199	4.46	Sept. 1	1925—34	Geo. B. Gibbons & Co.
Durham, N. C.	Improvement	1,300,000	4½	100.149	4.48	July 1	1925—66	Blair & Co., Inc., and others
Denver, Colo.	Improvement	282,300	5½	101.78	5.40	.....	.....	Chanute & Co. and others
Deal, N. J.	Improvement	132,000	4½	100	4½	Aug. 1	1925—55	Seacoast Trust Co.
Eustis, Fla.	Improvement	100,000	5½	99.55	5.55	July 1	1934—39	Atlantic Nat. Bank
Euclid, O.	Sewer, paving streets	308,369	6	103.04	5.35	Oct. 1	1925—34	Seasongood & Mayer
Fair Haven, Vt.	Improvement	35,000	4½	100.25	4.22	Nov. 1	1925—42	Allen Nat. Bank
Haverhill, Mass.	Street and sewer	40,000	4	100.525	3.80	Sept. 1	1925—29	Curtis & Sanger
New Haven, Conn.	Improvement	1,112,000	4	101.267	3.90	Nov. 1	1929—54	National City Co.

Steel, Lumber and Cement Demand Increasing

(*Concluded from p. 853*)

With construction labor, the demand is not so marked as in the case of building materials. While there is little unemployment throughout the nation at the present time there is a perceptible slackening of demand for labor in certain areas.

Telegraphic reports from *E. N.-R.* correspondents on the Pacific Coast state that "there is some unemployment but conditions not serious."

Plenty of building trades mechanics are available in most large cities. In the Southwest, however, there is a reported scarcity of bricklayers. In the Middle Atlantic section, tile setters and steam fitters are in urgent demand. In fact, for the whole country, the scarcity of building trades mechanics has been confined all along to about five crafts, namely: Plasterers, bricklayers, plumbers, tile setters and steam fitters.

Bids Wanted on Big Jobs

Store, Birmingham, Ala. by L. Spizitz, $1,000,000.

Bank and office, Utica, N. Y. by York and Sawyer, $1,500,000.

Large Contracts Let During Week

Railroad, Illinois, Illinois Central R.R. Co., 178 mi. line to Shugart & Blythe Bros., A. Guthrie & Co., Flick Constr. Co., Dominion Constr. Co., H. W. Nelson Co.

Apartment, New York, N. Y., J. Golding will build 15 story building. Work will be done by separate contracts, $2,500,000.

Storage Tanks, Big Lake, Tex., Marland Oil Co. to Chicago Bridge & Iron Wks., $2,000,000.

Hospital, New Orleans, La., Southern Baptist Hospital Comn. to Seidenbrech Constr. Co., $900,000 to $1,000,000.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of November 6, the next, on December 4.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$4.00	$3.00	$3.35	$3.50
Structural rivets, 100 lb.	3.75	4.35	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.30	3.38	3.00	3.25	3.87½	3.35	3.25	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	44%	54.2%	43%	53%	55.45%	36%	—44.7@55.5%	45%	37.83
Cast-iron pipe, 6 in. and over, ton.	—55.60@56.60	56.00	+59.00	—48.20@50.20	55.50	68.00	56.00	65.00	65.00
Concreting Material:									
Cement without bags, bbl.	.2.50@2.60	2.35	2.05	2.20	2.42	2.84	2.61	2.65	1.80
Gravel, ¾ in., cu.yd.	2.00	1.90	2.38	2.75	1.65	1.90	2.61	1.50	1.25
Sand, cu.yd.	1.00	1.40	2.00	2.75	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	2.75	1.75	2.50	2.15	3.00	2.25
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	55.00	34.00	57.20	55.00	38.75	36.75	29.00	+27.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	23.00	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	2.50@3.00	1.45	1.85	1.50	1.35	2.70	1.60	2.80	10.50
Common brick, delivered, 1,000	18.00	10.50	12.10	12.00	14.00	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.1004	.0941	.089	.07	.085	.....	.11	.12
Hollow partition tile 4x12x12, per block	.1162	.1004	.0941	.089	.....	.085	.108	.11	.10
Linseed oil, raw, 5 bbl. lots, gal.	+1.14	1.14	1.20	1.05	+1.17	+1.29	+1.16	1.12	1.13
Common Labor:									
Common labor, union, hour	.75	.30	.....	.82½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	....	.25	.40@.75	.75	50@.55	.35@.50	.50	.62½	25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; lump finishing lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.60 for Kelly Island and Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand stone, gravel and lump lime per ton. Stone, lime and tile are delivered; sand, gravel and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par. Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $37.83.

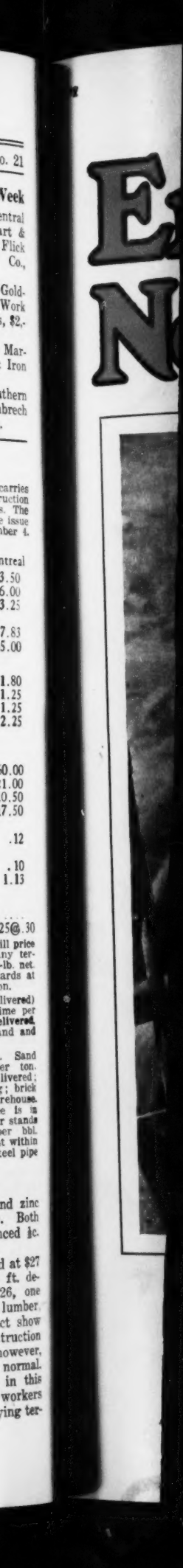
Conditions Affecting the Market

Building materials prices are on the upswing according to reports received this week by *Engineering News-Record*. With the exception of some fluctuation in c.-i. pipe quotations, all other changes have been upward.

Rises occurred principally in fir timbers and linseed oil. Raw oil in 5 bbl. lots, f.o.b. New York, jumped from $1.08 to $1.14 per gal. since last week. Advances of 4c. and 6c. per gal. occurred in San Francisco and Denver at the same time. Steel concreting materials, lime, lumber and clay products are all firmer, particularly in New York.

The pig-iron demand, although slightly better than a week ago, is mostly for delivery in the first quarter of 1925. Iron prices are higher in Philadelphia and Cincinnati. Iron and steel scrap is also firmer.

A strong upward trend has developed in steel structurals during the week. The minimum price is now $2 per 100 lb., Pittsburgh, against $1.80 last week. Reinforcing bars are also $2, with plates, $1.65@$1.90 per 100 lb. at Pittsburgh mills. Plates have advanced 5c. and shapes, 20c. per 100 lb. since Nov. 7.

With the exception of lead, the same upward tendency prevails in non-ferrous metals. Copper, tin and zinc were most affected by the rise. Both brass and copper tubing advanced ½c. per lb., this week.

Douglas fir timbers are quoted at $27 per M. ft. b.m. for 3 x 12, 20 ft. delivered in Seattle, against $26, one week ago. Despite this rise in lumber, reports from the Seattle district show a perceptible slackening of construction operations. Residential work, however, is still above the seasonal normal. There is some unemployment in this district owing to an influx of workers from farming, mining and outlying territories.